

Site:	Carrier Air
Break:	3.10
Other:	VI

COLLIERVILLE SITE

COLLIERVILLE, TENNESSEE

FINAL REMEDIAL INVESTIGATION REPORT

VOLUME 1



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REVISION B
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PREFACE

The Draft Remedial Investigation Report for the Collierville Site adopts certain conventions in reference to monitoring wells and sample identifications. An understanding of these conventions will assist the reader in interpreting data.

Odd numbers are used for monitoring wells which are screened in the shallow aquifer onsite. All of these wells are screened on top of or slightly into the aquitard. Even numbered wells are screened in the lower aquifer (Memphis Sands) at the top of the aquifer. The only exception to this numbering sequence are MW-1 and MW-1B both of which are Memphis Sands wells. Well numbers go through MW-61. Even numbered wells reach number MW-58; however, there are no even numbered wells between MW-16 and MW-58. In addition, there are references to wells for which no data exists because the wells do not produce sufficient water for sampling.

Sample identifications are constructed using the sampling date and well location; e.g. Sample 08299012 is a sample collected on August 29, 1990 from monitoring well 12. Alphabetical suffixes are used for quality assurance samples. FB means field blank. RS means rinsate sample. TB is a trip blank. MS is a matrix spike. MSD is a matrix spike duplicate.

Prefixes are used to specify samples that are not monitoring well samples. The prefix 'B' indicates a sample from a soil boring and the sample sequence; e.g. Sample B37-5 is a soil sample from boring 37 and is the fifth sample taken from the borehole. The depth and description of this sample can then be found by reference to the boring logs. However soil samples collected from borings that were converted into monitoring wells are expressed as

monitor well number with sequence; e.g. MW43-5 is the fifth sample taken from the borehole used to install monitoring well 43. NC indicates a surface water sample from Nonconnah Creek. D indicates a ditch water sample. USS and DSS indicate stream sediment samples upstream and downstream of the site. CW indicates sample from the city well field; and CMW indicates background wells installed offsite.

EXECUTIVE SUMMARY

The Collierville Site is the subject of a Remedial Investigation and Feasibility Study (RI/FS). The following is the Draft Remedial Investigation Report.

The Site has experienced three releases of trichloroethylene (TCE) which are suspected sources of TCE contamination in soils, shallow groundwater, and a municipal well field. A chronology of site activities is presented at the end of this executive summary.

The primary objective of the Remedial Investigation was to identify and confirm the nature and extent of trichloroethylene contamination at the Collierville Site. The investigation consisted of strategically placed borings completed to the top of the Jackson clay aquitard to aid in the physical description of the geology/hydrogeology as described in Section 5.3. The groundwater phase of the investigation included the installation and sampling of shallow and deep monitoring wells. The identification and quantification of hazardous substances was conducted in three phases.

Phase I

Phase I of the Remedial Investigation identified Site Constituents and confirmed previous work completed under the auspices of the Tennessee Department of Health and Environment. Earlier studies assumed that the parameters of concern for the Site were TCE and its degradation products. CLP sampling protocol for the target compound list confirmed the presence of TCE and its degradation products during Phase I. In addition, analyte analyses identified anomalous values of lead and zinc in shallow groundwater. Therefore, subsequent soil and groundwater sampling conducted during Phase II of the investigation were for volatile organics and metals.

Phase II and Phase III

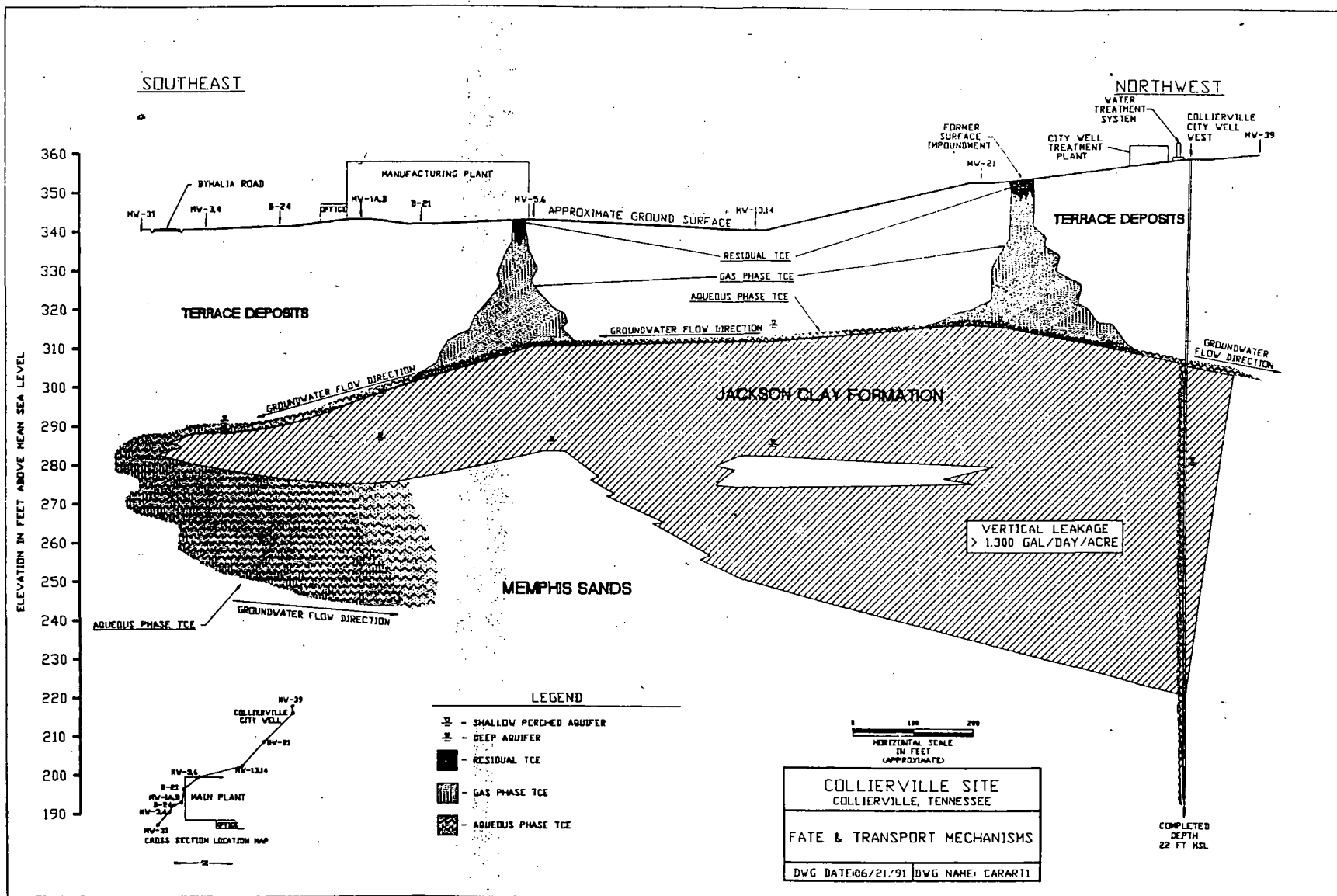
Phase II and Phase III of the Remedial Investigation obtained additional geological data from the Site and to characterize the extent of contamination. Soil borings conducted during the investigation confirmed the presence of TCE in soils in close proximity to the three source areas and confirmed migration of contaminants in the vadose zone through soil pore spaces as vapor phase diffusion. Although concentrations are variable with depth, isocons of contaminant distribution discussed in Section 5.5.1 indicate widespread impact on soils.

Quarterly groundwater samples indicated elevated levels of trichloroethylene in both aquifer systems at the Collierville Site. Groundwater flow in the shallow aquifer has provided a transport mechanism for contaminants in the aqueous phase across the property and contributed to contamination in the Memphis Sands. TCE movement on the Site is illustrated in the enclosed figure (Fate and Transport Mechanisms).

Soil and groundwater samples collected throughout the RI exhibited the same inconsistencies with relation to metals as identified in Phase I. Analytical results from the three background wells installed at various locations within the Collierville City limits (Figure 8-1, CMW-001-CMW-003) and other background information also showed anomalous levels of metals in groundwater. These factors suggest that metals are probably not Site constituents (Section 4.4).

Site Chronology

- 1967 - Well Field #2 Installed northwest of Site
- 1969 - Initial Site Development began by Carrier
- 1972 - Surface Impoundment installed north of plant
- 1979 - Spill occurs as a result of degreaser failure
- 1980 - Surface Impoundment taken out of service
- 1981 - Surface impoundment closed with off site shipment of soils
- 1985 - Spill occurs from TCE storage tank, soil excavation and spill assessment is initiated
- 1986 - Tennessee Department of Health and Environment performed Site assessment
- 1987 - Site placed on State Superfund list. Carrier initiates voluntary Site Investigation
- 1988 - Voluntary Site Investigation Report is released to TDHE and EPA
- 1989 - Site is proposed for National Priorities List and Carrier agrees to perform RI/FS; Carrier also installs groundwater removal and treatment system; and vapor extraction system.
- 1990 - Site is placed on National Priorities List. Carrier installs a treatment system at the well field to remove TCE from raw water supplies. Draft RI Report submitted to EPA.



1.0 INTRODUCTION

The United States Environmental Protection Agency ordered that an investigation be conducted of the Collierville Site in Collierville, Tennessee with the objectives "(A) to determine fully the nature and extent of any threat to the public health or welfare or the environment caused by the release or threatened release of hazardous substances, pollutants, or contaminants at or from the Site (Remedial Investigation); and (B) to evaluate alternatives for the appropriate extent of any remedial action to prevent or mitigate the migration or the release or threatened release of hazardous substances, pollutants, or contaminants at and from the Site (Feasibility Study)." [Reference, EPA, 1989] The Site has been placed on the National Priorities List (40 CFR 300) and the State of Tennessee's List of Sites established at rule 1200-1-13-.03. (the List, commonly referred to as the Tennessee Superfund List, contains the list of those sites within Tennessee where hazardous substances are present and which are eligible for investigation, identification, containment, cleanup, monitoring, and/or maintenance under the States Superfund Program).

The following is a Draft Remedial Investigation Report for the Collierville Site conducted to meet the first objective above. The investigation was conducted in accordance with a Remedial Investigation (RI) and Feasibility Study (FS) Work Plan approved by the United States Environmental Protection Agency, Region IV (EPA), and the State of Tennessee Department of Health and Environment (TDHE), Division of Superfund (DSF).

The RI was conducted for Carrier Corporation by Environmental & Safety Designs, Inc. (EnSafe). Aquifer pump tests were performed by Dames & Moore, Cincinnati, OH under subcontract to EnSafe. Geophysical surveying was also conducted by Dames & Moore, Cincinnati, Ohio, and Blackhawk Geosciences, Golden, Colorado, also under subcontract to EnSafe. A benthic organism study in Nonconnah Creek was performed by Jim Payne, Ph.D., and Chester Fiegel, both with Memphis State University under EnSafe supervision. The baseline risk assessment was completed by Frank Mink and Assoc., Cincinnati, Ohio. The RI Report includes data developed under previous work plans. The initial site investigation was conducted in 1987 and 1988 under the auspices of the Tennessee Division of Superfund. Additional field work was conducted in 1989 and 1990 under the EPA/TDHE approved RI Work Plan referenced above. This RI field work was conducted in three phases:

Phase 1 was a "Data Validation Study" [EnSafe, June, 1990] conducted to evaluate the quality of data obtained under previous investigations and to set a Site Constituents List for further work. Results of Phase 1 are presented in Section 4.0 of this report.

Phase II and III of the RI consisted of additional field work needed to close data gaps in prior work.

The Phase I "Data Validation Study" concludes that prior Site data was acceptable for use in the RI. Both EPA and TDHE concurred in this conclusion. Therefore the following Draft RI Report consolidates all data obtained under these State and Federally supervised investigations.

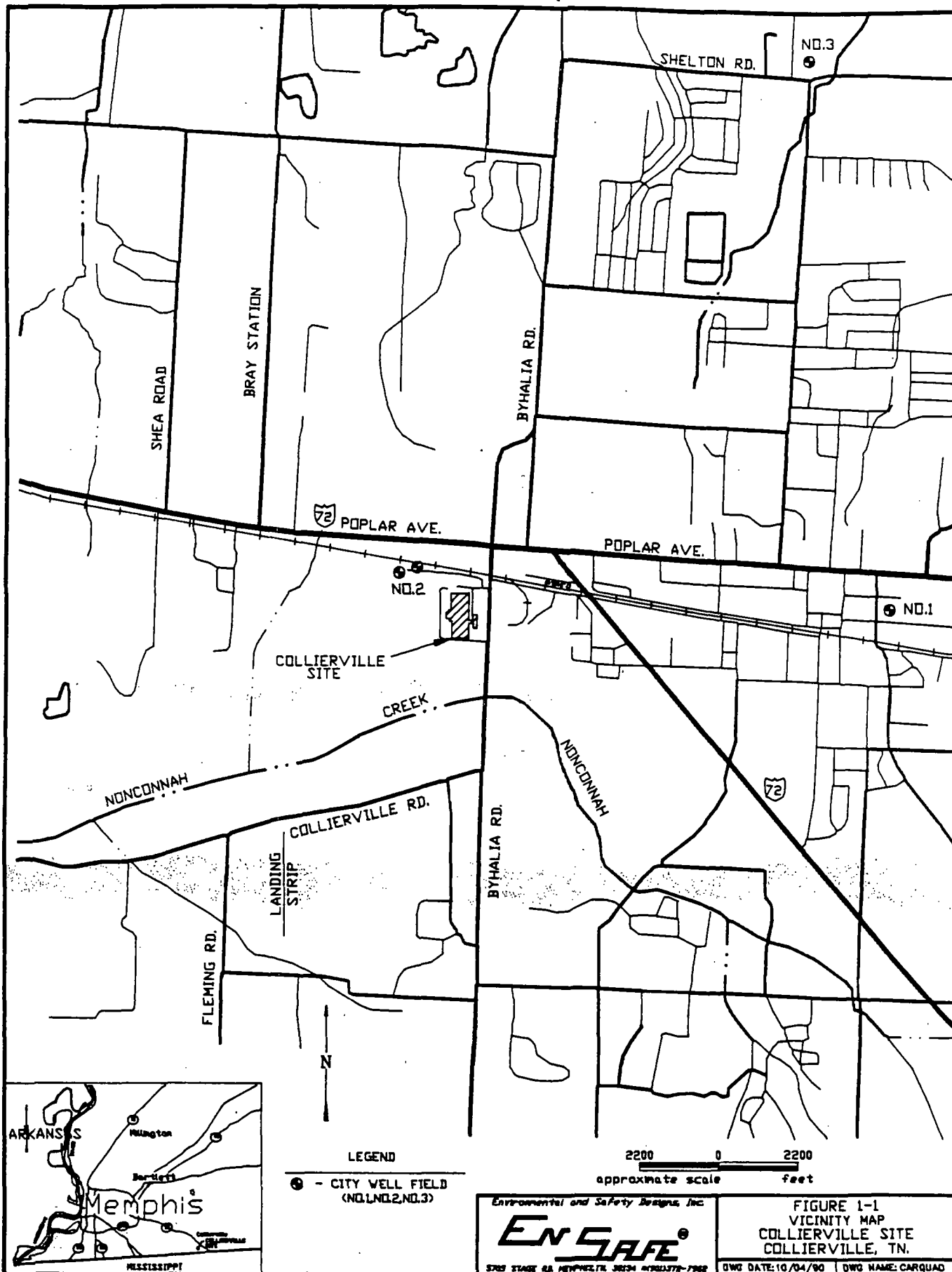
The following persons were responsible for the Site Investigation:

Carrier Project Coordinator	Nelson Wong
Carrier Site Contact	Carl Krull, CHMM
EnSafe Project Manager	Phillip G. Coop, CHMM
EnSafe Site Manager/Geologist	Paul V. Stoddard, RPG
EnSafe Quality Assurance Officer	Craig Wise
EnSafe Health & Safety Officer	Rick Barlow

1.1 Site Background Information

Location

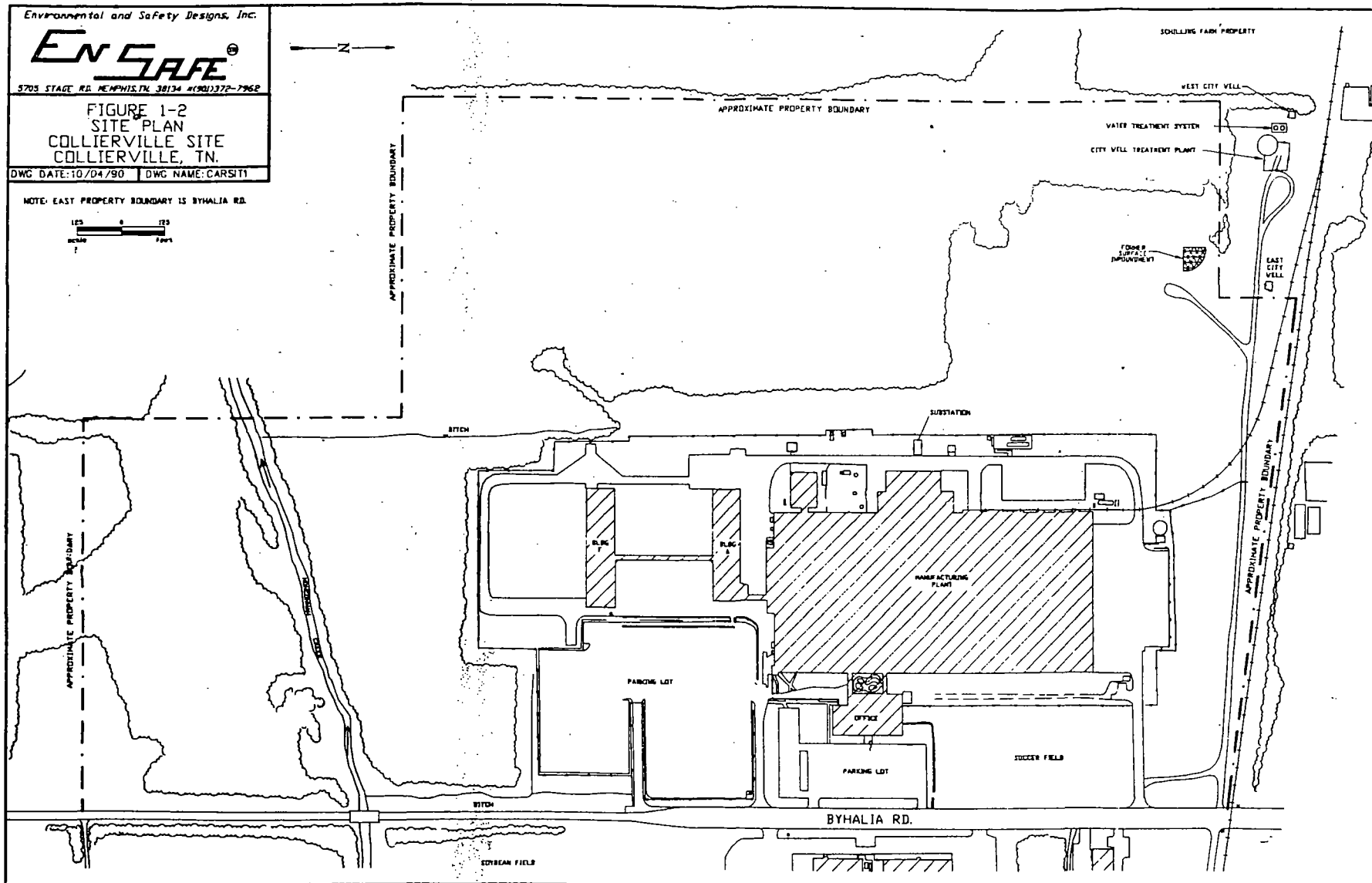
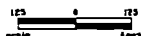
The Collierville Site is located on the western side of the Town of Collierville, Shelby County, Tennessee. Shelby County, TN is located in the southwest portion of the state and is bound to the north by Tipton County, to the east by Fayette County, to the south by DeSoto County, Mississippi, and to the west by the Mississippi River. The Site is located near the intersection of Poplar Avenue (U.S. Highway 72) and Byhalia Road. The address is 97 South Byhalia Road, Collierville, TN 38017. Collierville is located approximately 21 miles east of downtown Memphis, TN, Latitude 35° 02' 33", Longitude 89° 41' 00". The Site is located on the Collierville Quadrangle, USGS Topographic Map. Figure 1-1 is a location map showing the Collierville Site and vicinity. Figure 1-2 shows the Site itself and relevant features.



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FIGURE 1-2
SITE PLAN
COLLIERVILLE SITE
COLLIERVILLE, TN.

NOTE: EAST PROPERTY BOUNDARY IS BYHALIA RD.



Rapid development is occurring north and west of the Site, consistent with the growth of the Town of Collierville the population of which exceeds 13,000. (TDHE, 1986)

Climate

Collierville's climate is typical of the Memphis region which is humid with summer temperatures ranging from the low 80s°F to 100°F; and winter temperatures in the 40s°F. Average humidity is 50 to 60 percent. Average rainfall is 56 inches per year. Evapotranspiration averages 40 inches, most of which occurs between May and October. [TDHE, 1986]

Average wind speed is 10 miles per hour in winter and 7 miles per hour in summer. Predominant wind direction is north-northeast. [TDHE, 1986]

Description

Figure 1-3 is a topographic map of the Site. The information in Figure 1-3 is also contained in Plate 1, located at the end of this report. Plate 1 is a 1"=100' scale map, with 2-foot topographic contour lines prepared from an orthophotogrammetric survey conducted in early 1990. Currently the site slopes gently to the South and West. The Site has been graded and filled in various locations in order to change drainage patterns and adapt the land to manufacturing use. In general the western portion of the property has been graded and leveled, with excess dirt moved to the areas under Buildings A and F. A pond located at the western edge of the Main Plant has been filled. A drainage ditch running east/west on the western side of the property was removed; and an intermittent stream was rerouted around the area which became the Main Plant. Figure 1-4 illustrates the topographic changes.

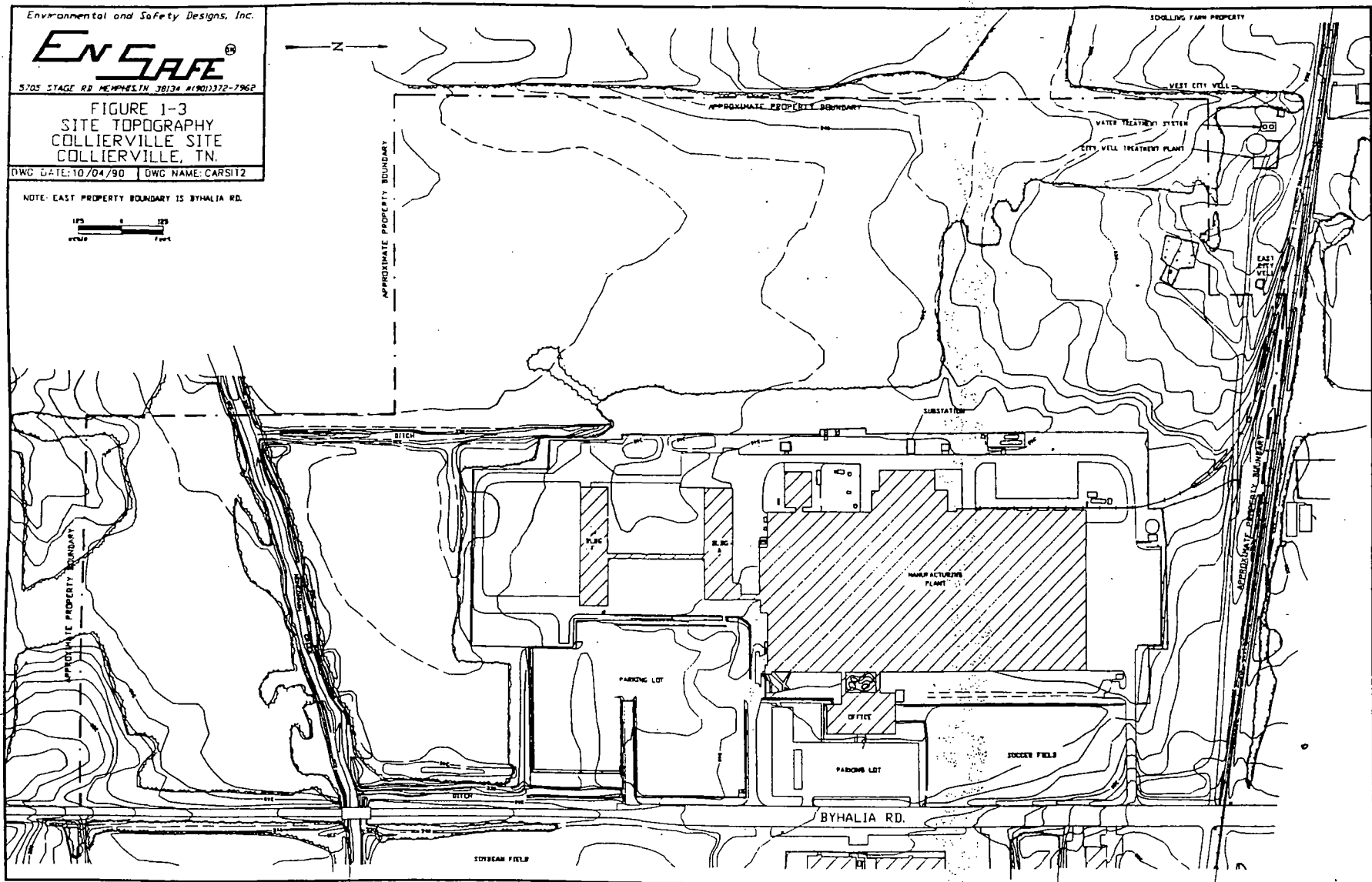


FIGURE 1-4
PRE-1970 SITE
TOPOGRAPHIC FEATURES
COLLIERVILLE SITE
COLLIERVILLE, TN.

NOTE: EAST PROPERTY BOUNDARY IS BYHALIA RD.



The Site consists of approximately 135 acres owned principally by Carrier Corporation (Carrier) which operates a manufacturing facility on the property. The land was agricultural until 1969 when manufacturing development began. Carrier, an air conditioning manufacturer developed the property in 1969-1970 and manufacturing began in 1971. Carrier's use consists primarily of four buildings: Main Plant which is an assembly plant for air conditioning units; Buildings A and F which contain storage and supporting operations; and an office building. (Buildings A and F were formerly manufacturing buildings. Pre-1989 maps of the site will show aboveground tubes connecting these two buildings. The tubes were used to move long lengths of aluminum cooling fins. The majority of these tubes have now been removed; however, a few are still in use for parts service.)

In 1967 the City of Collierville installed a well field for potable water on the northwest corner of the Site. The operation consists of two wells, described as the West Well and the East Well, a treatment plant, and a storage tank. This area is identified as Well Field #2 and provides up to 1.4 million gallons per day of potable water to the Town of Collierville. Although pumping rates vary depending upon demand, both wells are operational and currently in service.

1.2 Release Sites

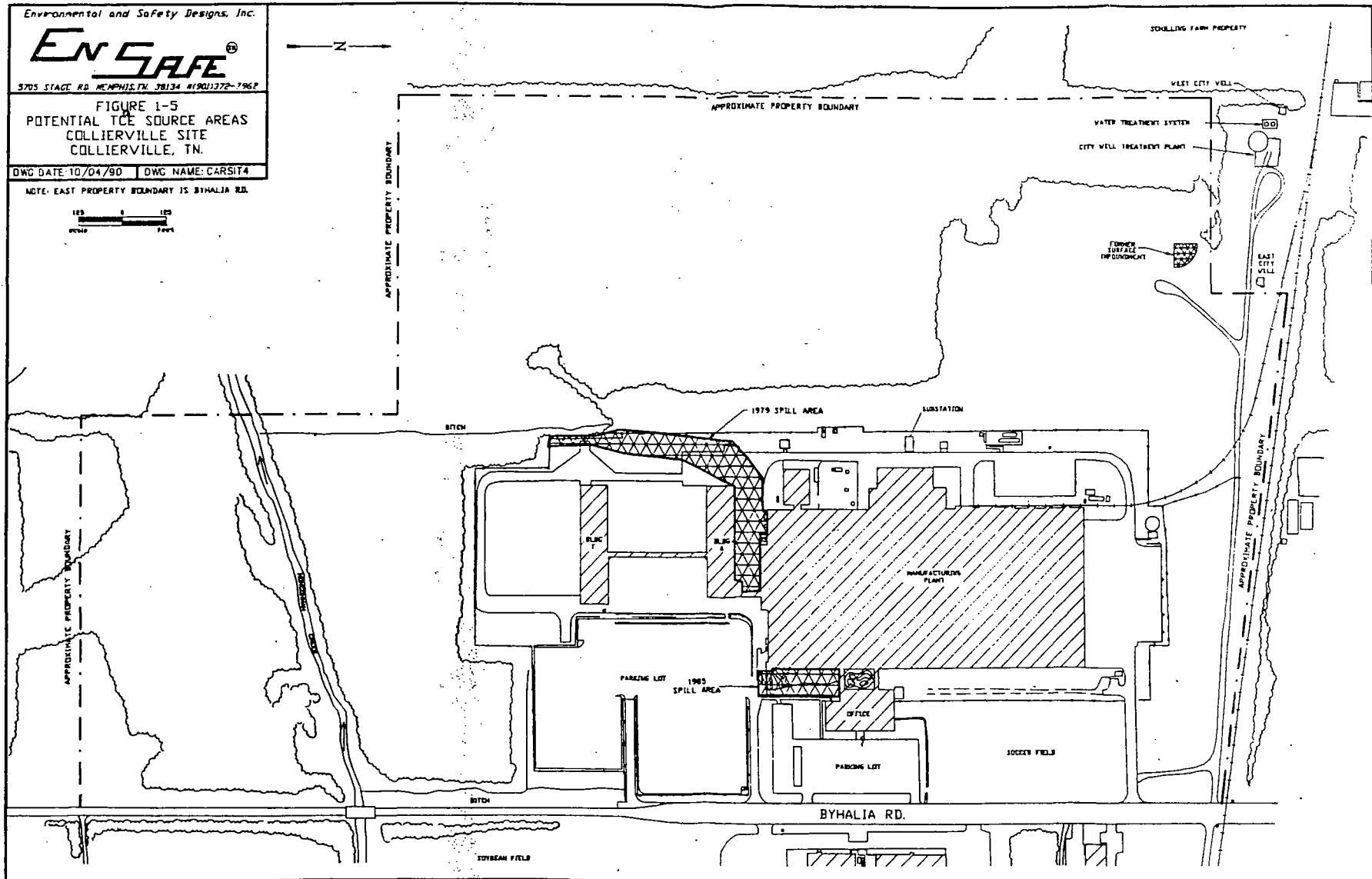
The State of Tennessee, Department of Health and Environment (TDHE) issued a Site Inspection Report (SIR) on the Carrier property in Collierville on 15 September 1986. The report stated that there have been documented releases of trichloroethylene (TCE) on the property. The three potential sources identified by the TDHE are: a 1979 trichloroethylene

release, a closed unlined surface impoundment and a 1985 trichloroethylene leak. The locations of these three alleged releases are shown on Figure 1-5. The figure shows areas believed to have been impacted by these releases. The shaded areas were the focus of the "source" investigation phase of the RI.

1979 Trichloroethylene Spill

In 1979, the Carrier plant experienced a spill of trichloroethylene from a heated degreasing unit located on the south side of the plant. The spill occurred as a result of the failure of a filter cover on the unit. At the time of the spill it was estimated that several thousand gallons of trichloroethylene were lost. The relative losses to air and ground surface are unknown.

The solvent collected on what was then the south parking lot. (This parking lot was located approximately at and south of the current location of Building A.) In response to the spill, the Collierville Fire Department was called. According to their report, residual material was washed off the parking lot by the municipal Fire Department in a generally western and southern direction. The asphalt parking lot was reportedly softened by the absorption of the solvent, and was therefore removed for off site disposal. Some washdown water containing TCE may have also been directed eastward by the Fire Department.



In 1981, six borings were advanced to 30 feet in the area thought to have been impacted by this 1979 spill. Samples were collected at five foot intervals and the resulting samples were analyzed for TCE. The tests were negative to a detection limit of 10 ppb. In 1986, TDHE collected eight soil samples in this area, two of which were positive for TCE at about 100 ppb and six of which were negative to the detection limit of 10 ppb.

Clarifier Sludge Surface Impoundment

In or about 1972, Carrier installed a wastewater surface impoundment on the northwest corner of the property. Data from the state's Site Investigation Report indicates that the surface impoundment was approximately 50' by 48' and contained approximately less than one foot of sludge at the time it was removed in 1980. The area was used for the storage of clarifier pit sludge which was essentially an alkaline zinc phosphate washer sludge according to plant personnel.

The exact location and construction details of the surface impoundment were not established when the investigation began. To aid in the approximate determination of the impoundment a 1969 topographic map [Jones & Mah, 1966] and an aerial photograph of the area [USDA, 1980] were used. However, the topography of the area was changed when the impoundment and a layer of subsoil beneath it were removed in 1980.

The location of the former surface impoundment has now been firmly established using historical aerial photographs (See Figure 1-5). The surface impoundment and its contents were removed by commercial contractor and disposed of in a waste management facility in Emelle, AL in 1981. The area was then regraded.

1985 Trichloroethylene Leak

On January 23, 1985 Carrier experienced a second release of trichloroethylene as a result of a pipe failure associated with an above ground tank holding trichloroethylene. An estimated 500 gallons were lost. In February, 1985 the TCE tank, associated piping, and up to 15 feet of soil were removed from the spill site. Immediate response operations resulted in the recovery of approximately 542 gallons of TCE. The amounts of TCE lost and recovered are best estimates made by Carrier at the time of the release. In May, 1985 soil samples from the excavation showed TCE at depths up to 30 feet from the surface.

Following soil removal, a spill investigation was conducted by Roy F. Weston, Inc. to assess the impact of the leak. A March, 1986 Weston report indicated that soil samples taken from the surface to the top of the "confining clay" were negative for TCE. As part of the spill investigation, five monitoring wells were installed on the property. Wells MW-1, MW-10, MW-12 AND MW-14 are screened in the deep aquifer on site. MW-13 is screened in the shallow aquifer. [Weston, 1986]

Well monitoring began in September of 1986 by EnSafe personnel. Two of these wells, one screened in the upper sand (MW-13) and one screened in the lower sand (MW-1), have shown measurable concentrations of trichloroethylene. (Note: Early Weston reports referred to these two wells as MW-1S and MW-4 respectively).

1.3 Nature and Extent of the Problem

On July 15, 1986 the City of Collierville's west well in well field #2 adjacent to the Site was sampled by TDHE and found to contain TCE. Subsequent analyses conducted on a bimonthly basis have shown values of TCE in the untreated water from the west well

averaging 21 ppb. Values in the east well have averaged 10 ppb for the untreated waters. At no time has the measured TCE in the treated water from Collierville's Water Plant #2 exceeded the EPA MCL of 5 ppb for trichloroethylene [Mathis 1990]. Values in treated water, prior to chlorination, averaged 4 ppb, prior to the installation of a treatment system to remove TCE. No TCE has been detected in the city drinking water since installation of the system in June 1990. The maximum contaminant level (MCLs) for TCE is 5 ppb. The MCLs for the cis and trans isomers of dichloroethylene have been established at 70 and 100 ppb, respectively.

In addition to the City of Collierville's well field #2, fifteen (15) private wells have been identified by TDHE within three miles of the site. Analyses of these wells by TDHE in September and October, 1986 were negative for TCE to a detection limit of 0.1 ppb. [TDHE, 1986]. Private wells were again sampled in the current investigation with no TCE detected at a detection limit of 5 parts per billion. Four of the private wells sampled during the RI were duplicates of those sampled by TDHE, Schilling Farms, Dr. Harold McCormick residence, Piper Plow Works, and the Dr. John Bennett residence.

Based on a review of background information and site characteristics, the site investigation focused as a primary goal on the identification and quantification of TCE in soils, subsoils, and groundwater on the site. Air, direct contact, surface water, and biological impacts were also evaluated.

1.4 Source Removal and Impact Reduction Actions

Carrier Corporation has taken a number of steps to remove/eliminate sources of TCE and reduce the impact of prior releases.

Following the 1979 spill, a large area of asphalt pavement and underlying soil was excavated and disposed off site prior to repaving.

The former surface impoundment was excavated in 1980 and shipped off site for disposal. In 1989, Carrier installed a groundwater recovery and treatment system, described in Section 6, to remove TCE contaminated groundwater and vapors in the area of the former surface impoundment.

After the 1985 release, Carrier initiated a massive soil excavation and testing program to remove TCE and TCE contaminated soils from the impact area.

In 1990, Carrier and the Town of Collierville designed and installed an air stripping tower system at the Well Field #2 Treatment plant. This 1.5 mgd system removes TCE from raw water prior to entry into the treatment plant and allows the Town to use Well Field #2 fully. The treatment system was designed to handle incoming TCE concentrations ten times the average values in raw water. Design, construction, and operation of this system was coordinated with and approved by the Tennessee Department of Water Supply (which permits water treatment systems), the Memphis-Shelby County Health Department, Bureau of Pollution Control (which has delegated authority for air emissions permitting), the State of Tennessee Division of Superfund, and the Town of Collierville. EPA, Region IV, was informed and concurred in the action.

The treatment system is monitored on a monthly basis at present. No TCE has been detected in the Town's treated water since installation of the system. (Detection limit is 0.3 ppb.)

1.5 References

Environmental & Safety Designs, Inc., (EnSafe) Phase 1 Report, Review of Data and Site Constituents, Collierville Site, June 4, 1990.

Environmental Protection Agency, Region IV, Administrative Order in the Matter of Collierville Site, Collierville, TN, April 29, 1989.

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Tennessee Department of Health and Environment (TDHE), Site Inspection Report, Carrier Air Conditioning, Collierville, TN, August 30, 1986.

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Walk, Jones, Mah & Jones, Architects, Inc., Site Grading Plan, Day & Night Manufacturing Company, November 25, 1966.

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2.0 REGIONAL GEOLOGY

2.1 Geologic Setting

The Memphis/Shelby County area is situated in two major physiographic subdivisions; the Mississippi Alluvial Plain and the Gulf Coastal Plain section. The Collierville Site is located in the Gulf Coastal Plain section which is distinguished by gently rolling topography and a characteristic thick layer of loess deposited during Pleistocene glaciation. Anomalous areas of loess deposition are associated with alluvial plains of Mississippi River tributaries that cross the area. These rivers include the Wolf River, the Loosahatchie River, and Nonconnah Creek [Graham and Parks, 1986].

The Collierville Site occupies a tract of land adjacent to and including a portion of Nonconnah Creek.

2.2 Hydrogeologic Setting

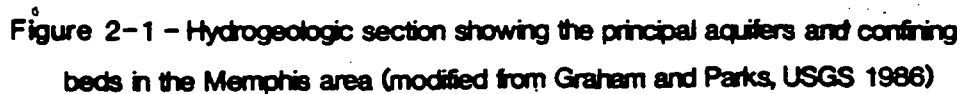
As much as 3000 feet of unconsolidated deposits overlie bedrock in the Memphis/Shelby County area. The sediments consist principally of sand, clay, gravel, silt, and some lignite. The principal freshwater aquifers in the designated area are: 1) the alluvium, 2) fluvial (terrace) deposits 3) the Memphis Sand, and 4) the Fort Pillow Sand [Graham, 1982]. The alluvium and fluvial deposits are separated in most areas from the Memphis Sands by the Jackson-upper Claiborne confining layer (locally referred to as the Jackson Clay). The Memphis Sands and the Fort Pillow Sands are separated by

the Flour Island confining layer. Figure 2-1 is a hydrogeologic section adapted from Parks and Graham (1986) showing the principal aquifers and confining beds in the Memphis area.

2.2.1 Stratigraphy and Lithology

The alluvium consist of a mixture of Holocene and Pleistocene fluvial sands, gravels, silts and clays that vary in thickness from 0-175 feet. Underlying the alluvium are eolian deposits of Pleistocene loess consisting primarily of silt, silty clay, and traces of sand with a thickness that varies from 0-65 feet. Quaternary Pleistocene and Tertiary Pliocene fluvial deposits consist primarily of sand, gravel and clay mixtures in terraces developed by fluvial and fluvial processes. Thickness of these deposits can vary from 0-100 feet (Stearns, 1975). A distinct boundary exists at the base of the fluvial deposits and the top of the underlying Eocene Jackson Clay.

The Jackson Clay is the uppermost unit in the Claiborne Group and marks the boundary between the Eocene and the overlying Pliocene Series of the Tertiary System. The Jackson Clay was deposited during the last transgressive phase of the sea occupying an arm of the Mississippi Embayment and both marine and non-marine facies are present in this unit (Cushing et al., 1964). The Jackson consists of dense, brown/gray to reddish clay and fine-grained sand-clay combinations mixed with lignite in some areas. In the Jackson, dense glauconitic clays are characteristic of the marine environments, while lignite and local sand-clay and sand lenses develop in the clay in the back-beach



environments. Thickness of the clay varies between 0-360 feet. The Jackson Clay grades into the Memphis Sand forming an indistinct boundary between the two units.

The Memphis Sand is a regressive thick-bedded sand unit deposited in near-shore to back-beach deltaic and alluvial environments. Oscillations of sea level in the Mississippi Embayment resulted in the grading of rivers and streams and the accumulation of this thick mass of coastal Claiborne sand. The Memphis Sand consists of massive beds of fine to coarse grained well-rounded to sub-angular sand and gravels intercalated with thin lenses and beds of silt, clay and argillaceous, micaceous and lignitic materials [Moore, 1965; Hosman, et al 1968]. The sand lacks fossils but remnants of well-developed flora exist. The interbedded clay/silt layers are up to 20 feet thick but appear to have only a local effect on hydraulics in the Memphis Sand. General strike is N-NE, dip is to the west towards the Mississippi River and total thickness generally varies between 500-850 feet. The Memphis Sand unconformably overlies the Eocene Flour Island Formation.

The Flour Island Formation, another Tertiary transgressive marine clay unit, is a dark gray-brown to greenish-brown carbonaceous clay with associated lignite. Local lenses of silty and sandy clay range in thickness between 1-50 feet and are interspersed throughout the unit along with indurated thin layers of sand and iron cement that forms hard streaks. Thickness of this unit varies between 160-395 feet. The Flour Island Formation marks the boundary between the Eocene Claiborne and Wilcox Groups and serves as a confining unit between the overlying Memphis Sand and the underlying Fort Pillow Sand.

The Fort Pillow Sand is a thick regressive Wilcox sand unit developed in a shallow-water near-shore environment. The well-sorted sand is fine grained in the upper half and fine to medium grained in the lower half. Clay lenses and lignite are dispersed throughout the sand. Thickness ranges between 210-280 feet in this aquifer unit.

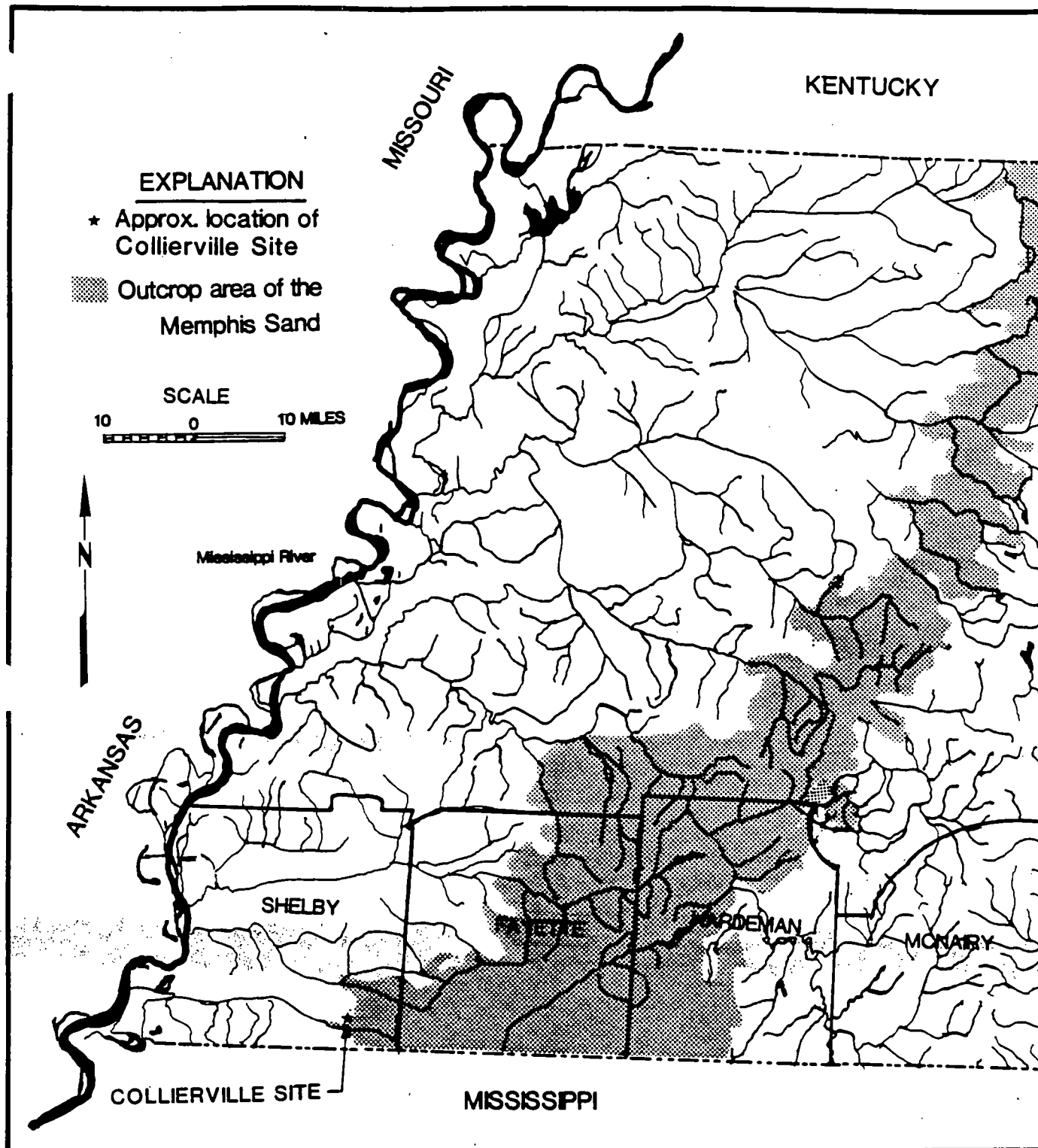
2.2.2 Hydrology

The alluvium and fluvial deposits comprise the shallow water table and show inconsistencies throughout the region. Presence or absence of shallow ground water may be indicative of "perched" zones characteristic of corresponding undulations in the subsurface associated to the Jackson Clay layer.

Graham and Parks (1986) suggest that the areal differences in the Jackson's ability to retard movement between the shallow ground water and the Memphis Sand is directly associated with the aggregate thickness of clay beds within the unit. However, the confining bed also contains fine sand and sandy silt, which causes local variation in its ability to retard the movement of water between the water-table aquifers and the Memphis Sand. Aggregate thickness of clay beds thicker than 10 feet in the Jackson-upper Claiborne confining bed range from 0-250 feet. As seen from Figure 2-1, the Jackson-upper Claiborne apparently pinches out in the vicinity of Nonconnah Creek resulting in a direct exchange of groundwater between aquifers. This is further substantiated by the location of the Collierville Site in relation to the outcrop area of the Memphis Sands.

Previous regional studies by the U.S. Geological Survey suggest that some recharge to the Memphis Sands may be directly related to vertical movement through the Jackson-upper Claiborne. Graham (1982) implies that a strong indicator of vertical leakage is that the regional cone of depression for the Memphis Sands is relatively shallow for current pumping rates. Brahan (1982) simulated these water levels using a digital flow model, but only after he had established a confining bed leakage factor of 20% from the overlying water-table aquifer. Graham and Parks (1986) give additional evidence for vertical leakage: (1) the aforementioned aggregate thickness of clay beds, (2) difference in hydraulic heads between the aquifers, (3) vertical and areal variations in carbon-14 and tritium concentrations in water from the aquifer, and (4) local deviations from the normal geothermal field as shown by geophysical temperature logs. Based on a subsurface study, Bradley (1987) concluded that groundwater at the Shelby County landfill was migrating vertically from the alluvial and fluvial deposits directly into the Memphis Sands.

The deeper Memphis Sands and equivalent deposits are confined throughout most of the Memphis area, except in the east and southeastern portions of Shelby County (Figure 2-2). The Fort Pillow Sand is artesian throughout the Memphis area and including the Collierville Site. Vertical interaquifer exchange between the Memphis Sands and the Fort Pillow Sands is restricted by the low hydraulic conductivity associated with the Flour Island confining layer.



Base from U.S. Geological Survey
State base map, 1977

Figure 2-2 - The outcrop area of the Memphis Sand (modified from Graham, USGS 1982).

2.3 References

A reassessment of the hydrogeologic setting in Shelby County has occurred recently in response to research conducted by the U.S. Geologic Survey. Two papers, in particular, are vital to a thorough understanding of County hydrogeology. They are:

Graham, D.D. and Parks, W.S. Potential for Leakage among the Principal Aquifers in the Memphis Area, Tennessee. U.S. Geological Survey, Water Resources Investigations Report 85-4295. Memphis, Tennessee. 1986.

Graham, David D. Effects of Urban Development on the Aquifers in the Memphis Area, Tennessee. U.S. Geological Survey, Water Resources Investigations Report 82-4024. Memphis, Tennessee. 1982.

Other References

Bradley, M.W. 1987, Evidence of Vertical Leakage to the Memphis Sand Aquifer Near the Shelby County Landfill, Memphis, Tennessee. U.S. Geological Survey, Open-File Report 88-322.

Cushing, E.M., Boswell, E.H. and Hosman, R.L., General Geology of the Mississippi Embayment. U.S. Geological Survey, Professional Paper 448-B, 1964.

Hosman, R. L. Long, R. T., et al., Tertiary Aquifers in the Mississippi Embayment. U.S. Geological Survey, Professional Paper 448-D, 1968.

2.3 References, cont.

Moore, G.K., Geology and Hydrology of the Claiborne Group, Western Tennessee. U.S. Geological Survey, Water-Supply Paper 1809-F, 1965.

Stearns, R. G., Field Trips in Western Tennessee. Tennessee Division of Geology-Report of Investigations No. 36, 1975.

3.0 INVESTIGATION METHODOLOGIES

On the basis of previous work and the Hazard Ranking Score documents, the RI focused on the need to determine the primary pathways of contamination movement from TCE source areas to groundwater, specifically shallow groundwater. Previous investigations at the Site had resulted in the installation of fifty-five (55) soil borings. Eighteen of these borings were completed as monitoring wells; ten (10) in the fluvial terrace deposits above the Jackson Clay, and (8) within the Memphis Sands aquifer beneath the Jackson clay layer.

To supplement earlier work (specifically to complete the determination of extent of contamination), a series of thirty two (32) additional borings were augered on site during the RI. Eighteen borings were completed as shallow monitoring wells and were screened in the fluvial deposits above the top of the Jackson aquitard. One boring was completed as a deep monitoring well (MW-58) and was screened within the Memphis Sands aquifer. Three (3) additional monitoring wells were installed in the uppermost aquifer at diverse locations within the Collierville city limits to establish additional background groundwater quality information.

The location, analytical protocol, and methodologies for samples collected from additional borings were chosen to achieve the following corollary goals:

- Verify (and determine validity of) past sampling and analyses.

- Identify, confirm, and describe the location of specific site constituents.
- Obtain additional geological data pertaining to the site.

In order to meet these objectives, the Remedial Investigation consisted of three (3) phases of field activities. The first Phase (Phase 1) of the investigation incorporated one shallow boring to the saturated zone above the Jackson Clay in each of the following study areas:

- 1) the 1979 spill site
- 2) the 1985 spill site
- 3) the former surface impoundment, and
- 4) a background sample from an area presumed to be free of contaminants.

Soil and groundwater samples collected from the Phase I field investigation were analyzed in accordance with full Contract Laboratory Procedures (CLP), for all Target Compound List (TCL) and Target Analyte List (TAL) compounds. The Phase I effort was described in a report accepted by EPA and dated June 4, 1990. It limited future analytical activities for Confirmed Site Constituents (CSCs) at the Collierville Site. The CSCs approved in the June 4, 1990, report for the Collierville Site identified volatile organics and metals.

Phase II and Phase III field activities were designed to close all data gaps and delineate the nature and extent of contamination.

3.1 Sampling Techniques

In order to minimize the potential for cross contamination during sample collection extreme care was taken during handling. Precautionary steps included the following:

- 1) Prior to individual sample collection, a clean piece of clear plastic was set down to serve as a work surface.
- 2) A clean pair of latex surgical gloves was worn each time an individual sample was collected.
- 3) All sample collection equipment was pre-cleaned and wrapped in aluminum foil prior to transportation to designated sample locations (Cleaning procedures are outlined in Section 3.5).
- 4) Field sampling teams consisted of at least two people. One person collected the sample and the other team member kept complete notes on sampling activities, conducted Health and Safety monitoring, and assured that proper sampling procedures were followed.
- 5) All disposable sampling equipment was stored in heavy weight plastic bags at the designated sample location. These were then transported to the designated decontamination area and stored in 55-gallon, DOT approved, steel drums.

- 6) Prior to drilling, a clean piece of plastic was placed under the rear of the drill rig to aid in containing auger spoils. During actual drilling activities all spoils were then transferred to 55-gallon, DOT approved, steel drums.
- 7) Drilling activities progressed from areas free of contamination to those areas which were suspect.
- 8) All equipment (sampling and drilling) used during the field investigation was decontaminated in accordance with the approved RI/FS Sampling Plan, Revision C, December 4, 1989. One modification to the approved decontamination procedure was the omission of the nitric acid rinse. This omission was approved by ESD oversight during the Phase I field investigation. In order to meet the criteria for organic free water for the field investigation a water treatment system was installed at the Site. This system consisted of potable water being introduced into a carbon treatment system and mixing bed for deionization. Treated water was then delivered to the decontamination area via a Teflon lined stainless steel spigot and hose.

Soil Samples

Soil samples collected from each of the boring locations were used to identify and confirm source area(s) of groundwater contamination. The borings were installed in the approximate locations identified on Figure 3-1.

FIGURE 3-1
SOIL BORING
LOCATIONS
COLLIERVILLE SITE
COLLIERVILLE, TN.

LEGEND

B-1 SOIL BORINGS
BORING NUMBER

125 0 125
feet



Phase I

Soil samples collected during the Phase I investigation were collected at eight (8) foot intervals to the top of the Jackson Clay confining layer utilizing a CME 55 drill rig. Samples were collected by driving a twenty four (24) inch split spoon sampling device into undisturbed soils through the annulus of four and one half (4 1/2) inch hollow stem augers. Upon retrieval of the sampler from the borehole, the sampler was opened and the sample designated for volatile analysis was immediately collected to minimize the risk of contaminant volatilization. The remaining sample was homogenized in a pre-cleaned glass or stainless steel bowl and subsequent samples were collected for the remaining analytical parameters. Soil samples during the Phase I field investigation were analyzed for full CLP TCL/TAL constituents. Soil samples were also analyzed for TCE by the soil screening methods outlined in Sect 4.

Soil samples were collected in laboratory cleaned jars and labeled for identification. Samples were preserved immediately in an ice chest at approximately 4 degrees C. A total of twenty four (24) soil samples were collected during Phase I of the field investigation.

Phase II and Phase III

Soil samples collected during Phase II and Phase III of the field investigation were collected at five-foot intervals to the top of the confining layer (Jackson Clay Formation). Sample collection techniques followed those outlined in the Phase I field investigation. The Phase I soil sample collection procedure was modified to allow for a third composite sample to be

collected in an 8 oz. glass jar. The jar was sealed and then held at room temperature for a period of six (6) to twelve (12) hours for qualitative headspace analysis using an hNu photoionization detector (PID) with a 10.7 eV probe. Table 3-1 contains the results of headspace determination made during Phase II and Phase III of the RI.

Based on the results of headspace analyses, soil samples collected during Phase II and Phase III of the field study were chosen for CLP confirmed site constituents. Specified samples with the highest PID readings were sent to the contract laboratory for analysis for confirmed site constituents. A split sample of each designated CLP sample and all remaining samples from each interval were analyzed utilizing the soil screening methodology outlined in Section 4. This method enabled the source area(s) to be quickly identified based on relative TCE concentrations measured at various locations and depths. Table 3-2 is a comparison of TCE concentrations based on field screening methodologies with actual CLP analytical results.

Soil borings completed during the investigation were pressure grouted from the bottom to the ground surface with the EPA approved cement/bentonite/water mixture. The mix ratio for the grout was approximately six (6) to seven (7) gallons of water per ninety four (94#) pound bag of Portland Cement. Bentonite powder was added at four (4) to five (5) percent by volume. No boreholes were backfilled with auger spoils.

TABLE 3-1
PHASE II HEADSPACE FIELD SCREENING
DATA FOR SOIL SAMPLES

Soil Boring or Monitoring Well Number	PID Background ppm	SAMPLE NUMBERS SAMPLES DEPTH IN FEET PID RESULTS IN PPM BENEATH EACH SAMPLE DEPTH											
		1	2	3	4	5	6	7	8	9	10	11	12
		3.5'	8-10'	13-15	18-20	23-25	28-30	33-35	38-40	43-45	48-50	53-55	58-60
B-41	0.02	0.8	0.8	0.8	1.0	1.0	0.8	0.8	*	*	*	*	*
B-42	0.3	1.8	0.8	0.4	1.2	1.0	0.4	1.2	1.4	1.2	1.0	2.6	*
B-43	0.4	3.2	26	21	28	2.6	26	3.4	4.4	3.6	*	*	*
B-44	0.0	1.8	2.8	NA	NA	NA	*	*	*	*	*	*	*
B-45	NA	NA	NA	NA	NA	1.1	0.8	*	*	*	*	*	*
B-46	NA	13	52	120	130	22	16	*	*	*	*	*	*
B-47	NA	1.2	0.8	1.6	2.8	3.0	0.6	5.4	18	26	10	12	*
B-48	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	*	*
B-49	NA	130	72	50	2.8	2.0	4.0	20	30	28	52	*	*
MW-25	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	*
MW-27	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	*
MW-29	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	*
MW-31	0.3	1.2	0.4	0.4	0.4	0.8	1.0	0.6	0.8	0.6	1.2	*	*
MW-33	NA	0.0	0.1	0.0	0.2	0.1	0.2	0.8	1.0	0.1	1.4	1.8	*
MW-35	0.2	0.2	0.4	NA	NA	NA	NA	NA	NA	*	*	*	*
MW-37	NA	1.0	0.4	0.2	0.1	0.0	0.3	30	30	1.8	18	*	*
MW-39	0.1	1.0	2.2	5.2	3.4	0.6	0.4	0.4	0.8	1.2	1.2	1.4	0.2
MW-41	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	*
MW-43	0.1-0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	*	*	*

**TABLE 3-1 (cont.)
PHASE II HEADSPACE FIELD SCREENING
DATA FOR SOIL SAMPLES**

Soil Boring or Monitoring Well Number	PID Background ppm	SAMPLE NUMBERS SAMPLES DEPTH IN FEET PID RESULTS IN PPM BENEATH EACH SAMPLE DEPTH													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
		3-5	8-10	13-15	18-20	23-25	28-30	33-35	38-40	43-45	48-50	53-55	58-60	*	*
MW-45	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
MW-49	0.0	0.2	0.2	0.1	0.2	0.7	0.4	0.0	0.0	*	*	*	*	*	*
MW-51	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.8	0.8	0.8	1.0	0.2	0.2	0.2
MW-53	0.0	0.4	0.2	0.3	0.2	0.3	0.1	0.2	0.2	0.2	0.3	0.2	0.3	*	*
MW-55	0.0	0.1	0.2	0.2	0.2	0.3	0.2	0.6	0.9	0.3	0.2	0.4	1.2	0.4	*
MW-57	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.4	0.2	0.0	0.0	*	*
MW-58	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.4	0.2	0.0	*	*	*
MW-59	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.3	0.1	0.4	0.1	0.1	*	*	*
MW-61	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.3	0.2	0.7	0.3	*	*	*
NOTE: Asterisk (*) indicates that a sample was not collected in this well at this corresponding depth. NA- indicates that information is not available due to mechanical difficulties with the PID.															

**TABLE 3-2
COMPARISON OF TCE CONCENTRATIONS
FIELD SCREENING METHODOLOGIES VS. CLP ANALYSES**

SOIL BORING OR MONITORING WELL	FIELD SCREENING VALUE $\mu\text{g/kg}$	CLP VALUE $\mu\text{g/kg}$
B37-1	<10	<6
B37-2	<10	<5
B37-3	<10	<5
B37-4	<10	<5
B37-5	<10	<5
B37-6	<10	<6
B37-7	N/A	<6
B38-1	299,000	3500E
B38-2	326	1J
B38-3	15,100	<6
B38-4	31	<5
B38-5	270	3J
B38-6	45	<6
B39-1	118	30
B39-2	122	69
B39-3	93	87
B39-4	53	<5
B39-5	117	<5
B39-6	76	<5
B40-1	1890	860E
B40-2	114	<6
B40-3	21	<5
B40-4	37	<5
B40-5	80	<5
B40-6	1230	1300
B41-7	<10	<6
B42-11	10	<5
B43-4	<10	2J

TABLE 3-2
COMPARISON OF TCE CONCENTRATIONS
FIELD SCREENING METHODOLOGIES VS. CLP ANALYSES

SOIL BORING OR MONITORING WELL	FIELD SCREENING VALUE $\mu\text{g/kg}$	CLP VALUE $\mu\text{g/kg}$
B44-3	<10	<6
B45-1	<10	<6
B46-4	56	80
B47-9	<10	<5
B48-1	<10	<6
B49-10	<10	8
B49-11	N/A	<6
MW27-12	<10	<6
MW29-12	<10	<6
MW31-10	<10	<6
MW33-11	N/A	<6
MW35-6	<10	<6
MW37-7	<10	<5
MW39-3	30	<6
MW41-10	<10	<5
MW43-9	<10	<6
MW45-11	<10	<6

NOTES: E - indicates the TCE concentration exceeds the upper quantitation limit. The result given is an estimation.

J - indicates the TCE concentration falls below the lower quantitation limit. The result given is an estimation.

N/A - indicates a result is not available.

Nonconnah Creek Sediment Samples

To support the proposed benthic study of Nonconnah Creek and to determine the surface water migration potential, two sediment samples were collected from the creek bed. One sediment sample was collected from an upstream location and one was collected from a downstream study location. The Creek sediment samples were collected with stainless steel spoons. To avoid localized variations in sediment, grab samples were collected within a ten foot radius and composited into a precleaned glass bowl. To minimize the risk of volatilization, those samples designated for volatile analysis were containerized immediately upon sampling. The volatile sample was collected from the first grab sample and prior to homogenization. Subsequent samples were thoroughly homogenized prior to containerization. Each sample location was flagged and recorded.

Sediment samples were analyzed by CLP procedures for the Confirmed Site Constituents and are further described in Section 7.

Well Field Water Samples

Samples of raw and finished drinking water from the Collierville Well Field #2 were also collected and analyzed throughout the investigation. Sampling taps exist on the pumps for wells and at each stage of treatment within the plant. Samples were collected at the West Well, East Well, after aeration, after chlorination, and at entry into the storage tank (finished water). After installation of the air stripping tower, samples were also collected "after

stripping," (AS) sampling was also conducted by the Town of Collierville, TDHE, and EPA at various times.

Well field samples collected during Phase I of the RI were analyzed for full CLP TCL/TAL constituents and by EPA Method 601 to aid in validating historical data (Section 4). Subsequent samples collected during the RI were analyzed for confirmed site constituents.

3.2 Monitoring Well Installations

Drilling for the borings completed as monitoring wells also incorporated the use of hollow stem auger techniques. Shallow wells were installed at the top of the Jackson clay formation and ranged from thirty (30) to sixty (60) feet below ground surface. Drilling was performed using a truck mounted CME 55 drill rig. Initial augering and sampling were conducted utilizing three and one quarter (3.25) inch I.D. hollow stem augers. Upon completion of soil sampling, the small diameter augers were retrieved and the boring was overdrilled utilizing six and one quarter (6.25) inch I.D. hollow stem augers and the wells were set through the annulus of the augers. Deep monitoring wells ranged in depth from one hundred (100) to one hundred ten (110) feet and were installed utilizing mud rotary techniques.

None of the well installations in the RI study were placed in areas suspected or found to have high concentrations of contaminated soils during drilling. This minimized the potential for cross contamination from surface soils to shallow aquifer. Site wells in proximity to the source areas had been installed during previous studies.

Soil samples were collected from soil borings completed as monitoring wells at five foot intervals using a twenty four (24) inch split spoon sampling device. Techniques outlined above for soil borings were consistent with those followed during well installation.

Shallow wells were screened from the interface of the clay aquitard through the bottom five feet of the fluvial terrace deposits. Monitoring wells MW-29, MW-31, MW-59, and MW-61, installed east of Byhalia Rd. were screened at an interval below the elevation of the Jackson confining layer as identified in MW-3 immediately west of Byhalia Rd. The screened interval was set at the base of the fluvial terrace deposits and just above what was thought to be the uppermost portion of the Memphis Sands. During previous investigations at the Collierville Site Boring 30 which was installed east of Byhalia Rd. was completed at approximately seventy (70) feet and indicated that the Jackson Clay was absent in this area.

Shallow well construction incorporated five (5) foot sections of 0.010 slot, stainless steel screen attached to a ten (10) foot section of stainless steel riser. The remaining riser located in the unsaturated zone was completed with galvanized steel. In addition, threads separating the joints between the stainless and galvanized riser were wrapped with Teflon tape to

minimize the potential for bimetallic corrosion in those wells where water in the saturated zone or the capillary fringe extended above the screened interval. Additional supplies of screen and riser received during the investigation were prefabricated with stainless steel threads to facilitate coupling; consequently, Teflon tape was omitted in some well constructions.

The screened interval of each well was backfilled (by tremie method) with clean silica sand (U.S.C.S. 10-20) to approximately two (2) feet above the screen, and sealed with a minimum of two (2) feet of bentonite. The silica sand and the one quarter (0.25) inch Pel Plug pure bentonite pellets were emplaced around and above the well screen utilizing a two (2) inch diameter PVC tremie pipe that was decontaminated and wrapped in clean plastic prior to each use. The depths to the sand pack and the bentonite seal were confirmed using the tremie pipe and a tape measure at the surface. The bentonite pellets were charged with organic free water and allowed to hydrate for a minimum of eight (8) hours. The augers were left in the borehole above the bentonite seal during this eight (8) hour period to prevent sloughing and caving of natural materials into the annular space. The well was then pressure grouted to the ground surface with a cement/bentonite grout. The mix ratio for the grout was approximately six (6) to seven (7) gallons of water per ninety four (94#) pound bag of Portland Cement. Bentonite powder was added at four (4) to five (5) percent by volume. To facilitate sampling procedures and further protect the integrity of each well, a 4'x 4'x 6" pad with an outward slope was constructed around nine (9) of the ten (10) monitoring wells. Monitoring well MW-27, was installed off site. As a condition to well installation was flush mounted to the driveway surface with no concrete pad. Four additional wells (MW-29,

MW-31, MW-57, and MW-58) were flush mounted as conditions for installation, but are protected by concrete pads. The remaining wells were installed with approximately two (2) feet of stick-up with a protective steel casing and protective guard pipes. All wells were provided with locking caps, and keys remained under close control.

The deep wells which penetrated the Jackson Formation clay to monitor the underlying Memphis Sand aquifer were designed to minimize the potential for cross contamination from the shallow aquifer. Borings for the deep wells were made utilizing 10.25 O.D. (outside diameter) hollow stem augers. Drilling with the augers was extended a minimum of two (2) feet into the clay aquitard. A length of four (4) inch carbon steel surface casing was then set on the base of the borehole through the annulus of the augers. The augers were removed and the surface casing was pressure grouted in place to seal the base of the shallow aquifer. The grout was allowed to set a minimum of twenty four (24) hours prior to resumption of drilling. Mud rotary drilling was used to proceed through the protective casing and into the lower aquifer. The drilling fluids were a mix of pure sodium bentonite powder and potable water. The consistency of the mud was maintained as light a mix as possible to effectively maintain the integrity of the borehole wall.

All the deep wells (except MW-58) were screened at the top of the underlying Memphis Sands aquifer. Upon reaching the desired depth, the drill stem was removed and a ten foot

section of 2-inch, 60 mesh stainless steel screen attached to galvanized steel riser pipe was installed. MW-58 installed during Phase III was screened from approximately twenty five to thirty five feet beneath the Jackson Clay. MW-58 was constructed utilizing a ten foot section of 2-inch, 0.010 slot, stainless steel screen attached to a corresponding section of stainless steel riser pipe to ground surface. The wells were completed as outlined above. Each of the wells was developed to remove drilling fluids and to maximize the wells communication with the aquifer.

Details of all well installations, including location of filters and seals, types of materials, total depth, and top of casing elevations are presented in Table 3-3. Table 3-3 also indicates that MW-17 was not installed during previous Site studies. During drilling of MW-17 no saturated zone was encountered; therefore, the decision was made not to install the well. The same conditions were encountered during the installation of MW-19; however, the decision was made to install the well as a "sump" set into the Jackson Clay.

To further facilitate field activities the well numbering system incorporated during the investigation designated even numbered wells for those wells screened in the Memphis Sands. Odd numbered wells are screened on top of or slightly penetrating the top of the Jackson Clay aquitard. The only exceptions to this numbering sequence are MW-1 and MW-1B which are screened within the Memphis Sands and MW-1A screened in the shallow unit.

Table 3-3
Monitoring Well Construction Data

Well	Total Borehole Depth (ft)	Total Well Depth (ft)	Well Bottom Elevation (msl)	Depth Top of Filter (ft)	Depth Top of Seal (ft)	Ground Surface Elevation (msl)	Elevation Top of Casing (msl)	Lgth (ft)	Well Screen Slot Size (in)	Material (type)	Well Dia. (in)
1*	102.49	105.00	234.11	100.00	93.00	341.11	343.62	15	0.010	Stnls	2
1A	47.00	48.08	294.23	36.00	33.00	341.03	342.31	5	60 Mesh	Stnls	2
1B	100.61	103.00	240.05	67.00	63.00	341.11	343.50	10	60 Mesh	Stnls	2
3	53.33	53.83	286.22	35.33	33.17	338.11	340.05	5	60 Mesh	Stnls	2
4	83.00	83.17	256.78	59.83	57.66	338.08	339.95	10	60 Mesh	Stnls	2
5	35.00	37.08	306.52	26.00	24.00	341.49	343.60	5	60 Mesh	Stnls	2
6	80.00	81.67	261.59	56.50	54.50	341.53	343.26	10	60 Mesh	Stnls	2
9	54.67	55.67	286.83	40.10	37.10	341.83	342.50	5	60 Mesh	Stnls	2
10*	88.25	90.27	253.39	72.27	65.00	341.64	343.66	5	0.010	Stnls	2
11	49.00	50.58	292.88	35.00	33.00	341.99	343.46	5	60 Mesh	Stnls	2
12*	102.79	105.15	239.29	85.00	79.00	342.08	344.44	15	0.010	Stnls	2
13*	31.11	33.66	309.16	23.66	17.66	340.27	342.82	15	0.010	Stnls	2
14*	108.02	110.55	232.36	92.55	85.55	340.38	342.91	15	0.010	Stnls	2
15	48.50	49.50	288.55	37.00	35.50	336.80	338.05	5	60 Mesh	Stnls	2
16	98.50	100.96	237.12	60.00	54.00	335.60	338.08	10	60 Mesh	Stnls	2
17#	53.50	----	----	----	----	358.10	----	--	----	----	-
19	54.50	55.98	303.71	36.00	34.00	358.50	359.69	5	60 Mesh	Stnls	2
21	44.00	44.98	308.37	26.50	25.70	351.60	353.35	5	60 Mesh	Stnls	2
23	33.50	34.77	305.82	18.00	17.00	338.50	340.59	5	60 Mesh	Stnls	2
25	47.90	50.07	295.00	40.50	38.20	342.90	345.07	5	.010	Stnls	2
27	60.56	60.08	282.74	55.30	53.10	343.30	342.82	5	.010	Stnls	2
29	60.07	60.07	277.23	52.30	50.1	337.30	337.30	5	.010	Stnls	2
31	49.89	50.07	287.31	37.00	35.00	337.20	337.38	5	.010	Stnls	2
33	54.05	56.62	281.85	45.70	43.20	335.90	338.47	5	.010	Stnls	2
35	30.24	32.14	304.76	23.00	21.00	335.00	336.90	5	.010	Stnls	2
37	48.62	50.20	300.98	40.00	38.00	349.60	351.18	5	.010	Stnls	2
39	58.19	59.99	301.51	50.20	48.10	359.70	361.50	5	.010	Stnls	2
41	53.15	55.09	296.75	43.00	41.00	349.90	351.84	5	.010	Stnls	2
43	43.92	46.33	311.68	36.10	34.10	355.60	358.01	5	.010	Stnls	2

Table 3-3
Monitoring Well Construction Data, cont.

Well	Total Borehole Depth (ft)	Total Well Depth (ft)	Well Bottom Elevation (msl)	Depth Top of Filter (ft)	Depth Top of Seal (ft)	Ground Surface Elevation (msl)	Elevation Top of Casing (msl)	Well Screen Lgth (ft)	Slot Size (in)	Material (type)	Well Dia. (in)
45#	55.00	-----	-----	-----	-----	-----	-----	-	-----	-----	-
47	35.00	34.00	308.82	27.00	25.00	339.75	342.82	5	.010	Stnls	2
49	40.00	33.00	316.29	26.00	24.00	349.29	351.62	5	.010	Stnls	2
51	64.00	62.00	296.24	53.00	51.00	358.24	361.33	5	.010	Stnls	2
53	62.50	62.50	298.82	55.50	53.50	361.32	363.49	5	.010	Stnls	2
55	65.00	62.00	292.86	51.00	49.00	351.89	354.86	5	.010	Stnls	2
57	57.00	55.50	304.37	43.00	40.00	359.87	359.87	5	.010	Stnls	2
58	181.00	181.00	178.86	164.80	160.70	359.86	359.95	10	.010	Stnls	2
59	59.30	59.30	277.93	29.00	27.00	337.37	337.23	5	.010	Stnls	2
61	60.27	60.27	276.88	32.00	30.00	337.15	336.88	5	.010	Stnls	2

* Wells installed by others prior to 1987

Well not installed

^From top of casing

Table 3-3
Monitoring Well Construction Data, cont.

Well	Well Material	Filter Pack Type	Annular Seal	Bentonite Seal	Borehole Diameter (IN. ID)	Protective Casing (Type III Well)	Drilling Methods	Comments
1*	Galv.	Grvl	Grout	Yes	8.50	Yes		
1A	Galv.	Sand	Grout	Yes	8.50	No	H.S.	
1B	Galv.	Sand	Grout	Yes	8.50	Yes	H.S./Mud	
3	Galv.	Sand	Grout	Yes	8.50	No	H.S.	
4	Galv.	Sand	Grout	Yes	8.50	Yes	H.S./Mud	
5	Galv.	Sand	Grout	Yes	8.50	No		
6	Galv.	Sand	Grout	Yes	8.50	Yes	H.S./Mud	
9	Galv.	Sand	Grout	Yes	8.50	No	H.S.	
10*	Galv.	Sand	Grout	Yes	Unknown	Yes		
11	Galv.	Sand	Grout	Yes	8.50	No	H.S.	
12*	Galv.	Sand	Grout	Yes	8.50	Yes		
13*	Galv.	Grvl	Grout	Yes	8.50	Yes		
14*	Galv.	Grvl	Grout	Yes	8.50	Yes		
15	Galv.	Sand	Grout	Yes	8.50	No	H.S.	
16	Galv.	Sand	Grout	Yes	8.50	Yes	H.S./Mud	
17#	----	----	----	----	8.50	No	H.S.	
19	Galv.	Sand	Grout	Yes	8.50	No	H.S.	
21	Galv.	Sand	Grout	Yes	8.50	No	H.S.	
23	Galv.	Sand	Grout	Yes	8.50	No	H.S.	
25	Galv/st	Sand	Grout	Yes	10.25	No	H.S.	
27	Galv/st	Sand	Grout	Yes	10.25	No	H.S.	
29	Galv/st	Sand	Grout	Yes	10.25	No	H.S.	
31	Galv/st	Sand	Grout	Yes	10.25	No	H.S.	
33	Galv/st	Sand	Grout	Yes	10.25	No	H.S.	
35	Galv/st	Sand	Grout	Yes	10.25	No	H.S.	
37	Galv/st	Sand	Grout	Yes	10.25	No	H.S.	
39	Galv/st	Sand	Grout	Yes	10.25	No	H.S.	
41	Galv/st	Sand	Grout	Yes	10.25	No	H.S.	
43	Galv/st	Sand	Grout	Yes	10.25	No	H.S.	

* Wells installed by others prior to 1987

Well not installed

^ From top of casing

Table 3-3
Monitoring Well Construction Data, cont.

<u>Well</u>	<u>Well Material</u>	<u>Filter Pack Type</u>	<u>Annular Seal</u>	<u>Bentonite Seal</u>	<u>Borehole Diameter (IN. ID)</u>	<u>Protective Casing (Type III Well)</u>	<u>Drilling Methods</u>	<u>Comments</u>
45#	Stainless	Sand	Grout	Yes	8.50	No	H.S.	
47	Stainless	Sand	Grout	Yes	8.50	No	H.S.	
49	Stainless	Sand	Grout	Yes	8.50	No	H.S.	
51	Stainless	Sand	Grout	Yes	8.50	No	H.S.	
53	Stainless	Sand	Grout	Yes	8.50	No	H.S.	
55	Stainless	Sand	Grout	Yes	8.50	No	H.S.	
57	Stainless	Sand	Grout	Yes	8.50	No	H.S.	
58	Stainless	Sand	Grout	Yes	10.25	Yes	H.S./Mud	
59	Stainless	Sand	Grout	Yes	8.50	No	H.S.	
61	Stainless	Sand	Grout	Yes	8.50	No	H.S.	

Field Survey

Upon completion of the field investigation, a point at the top of each well was permanently marked and surveyed to establish the location and elevation relative to mean datum by a Registered Tennessee Surveyor. Water levels throughout the investigation were measured from the permanent mark on the casing (as surveyed) to aid in the development of groundwater flow maps and the determination of casing volumes for sampling.

Well Development

Dvelopment of the monitoring wells began after the grout had set for a minimum of twenty four (24) hours. Each of the Phase II wells that produced sufficient water for pumping were developed by utilizing a stainless steel Arch well development pump attached to pneumatic controller supplied by bottled nitrogen. Slow aquifer recharge hindered pumping and additional development incorporated the use of dedicated Teflon hand bailers. Development continued until groundwater turbidity was at a minimum (ranging from slightly to moderately turbid). Insufficient recharge in the shallow aquifer restricted complete development of some wells. Shallow wells have been bailed dry on numerous occasions with little change in conditions. MW-27 and MW-31 currently exhibit moderately turbid water.

Gamma Logging of Monitoring Wells

Upon completion of the field investigation, all monitoring wells at the Collierville Site were gamma logged. The gamma logs were used in conjunction with the boring logs to provide

a more complete description of the subsurface geology. Logging data is summarized in Section 5.

3.3 Groundwater Samples

During all phases of the RI, groundwater samples were collected from all wells both old and new on the Collierville Site that produced sufficient groundwater for sampling. Additionally, all existing site monitoring wells were sampled once per quarter upon completion of four consecutive quarters of CLP volatiles and metals analyses. Subsequent analytical procedures for individual wells included SW-846 methodologies for volatiles and metals. Table 3-4 indicates those wells that were sampled throughout the RI quarterly sampling events. Figure 3-2 is a facility layout that identifies all on-site monitoring wells.

Groundwater samples were used to characterize the groundwater quality of each aquifer unit and identify potential migration pathways. Figure 3-3 locates all off-site monitoring wells installed during Phase III.

During each quarterly sampling event, a groundwater level was measured and recorded for each well. These measurements were then converted to elevations relative to set datum (mean sea level). Calculations were made from groundwater levels to establish casing volumes. Prior to collection of groundwater samples, each well was purged of a minimum of three casing volumes, or was bailed dry. These procedures were implemented to ensure fresh groundwater recharge for sample collection. Water quality parameters (pH, temperature, and conductivity measurements) were recorded beginning in the December 1990

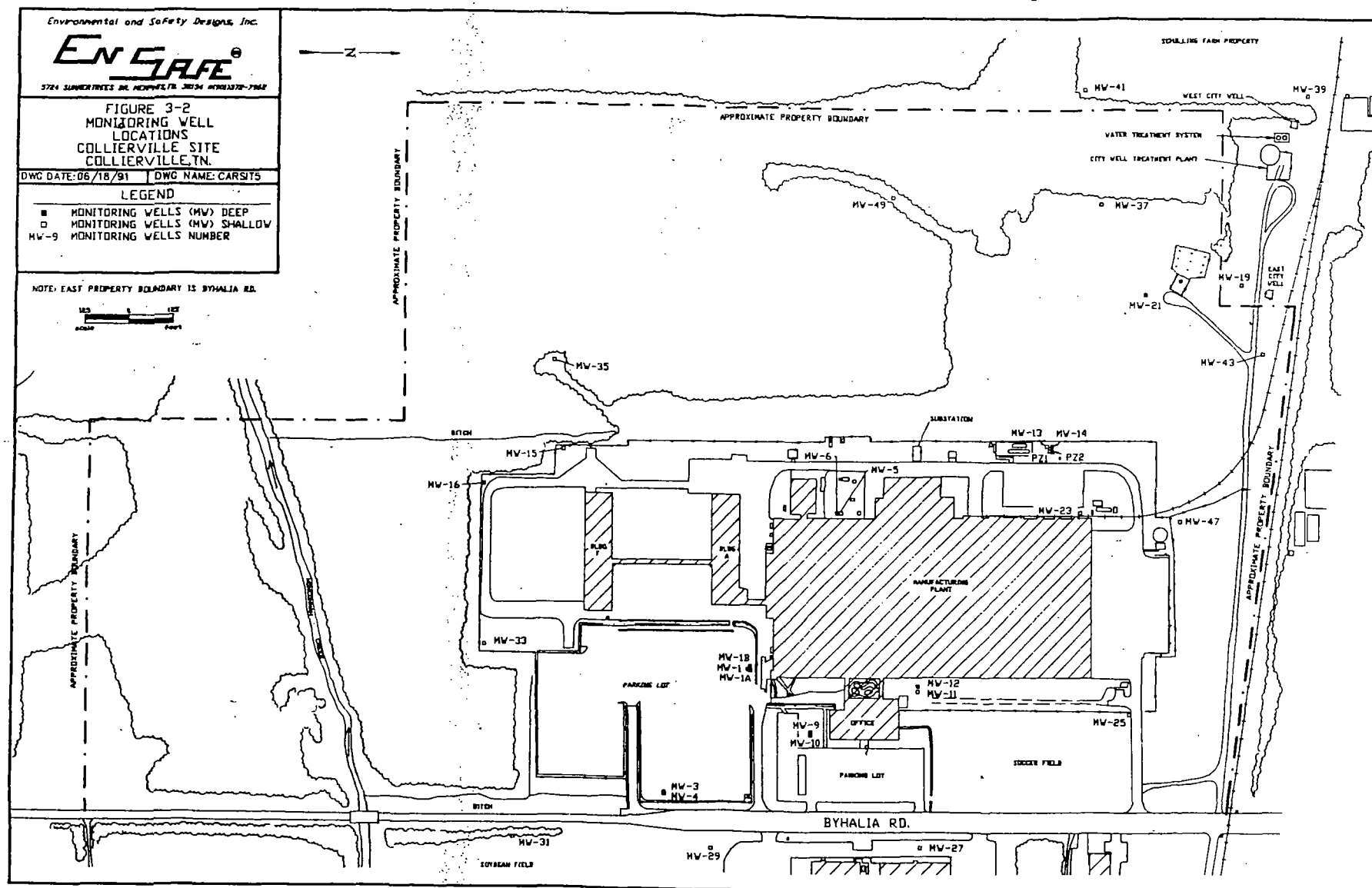
Table 3-4
QUARTERLY SAMPLING EVENTS

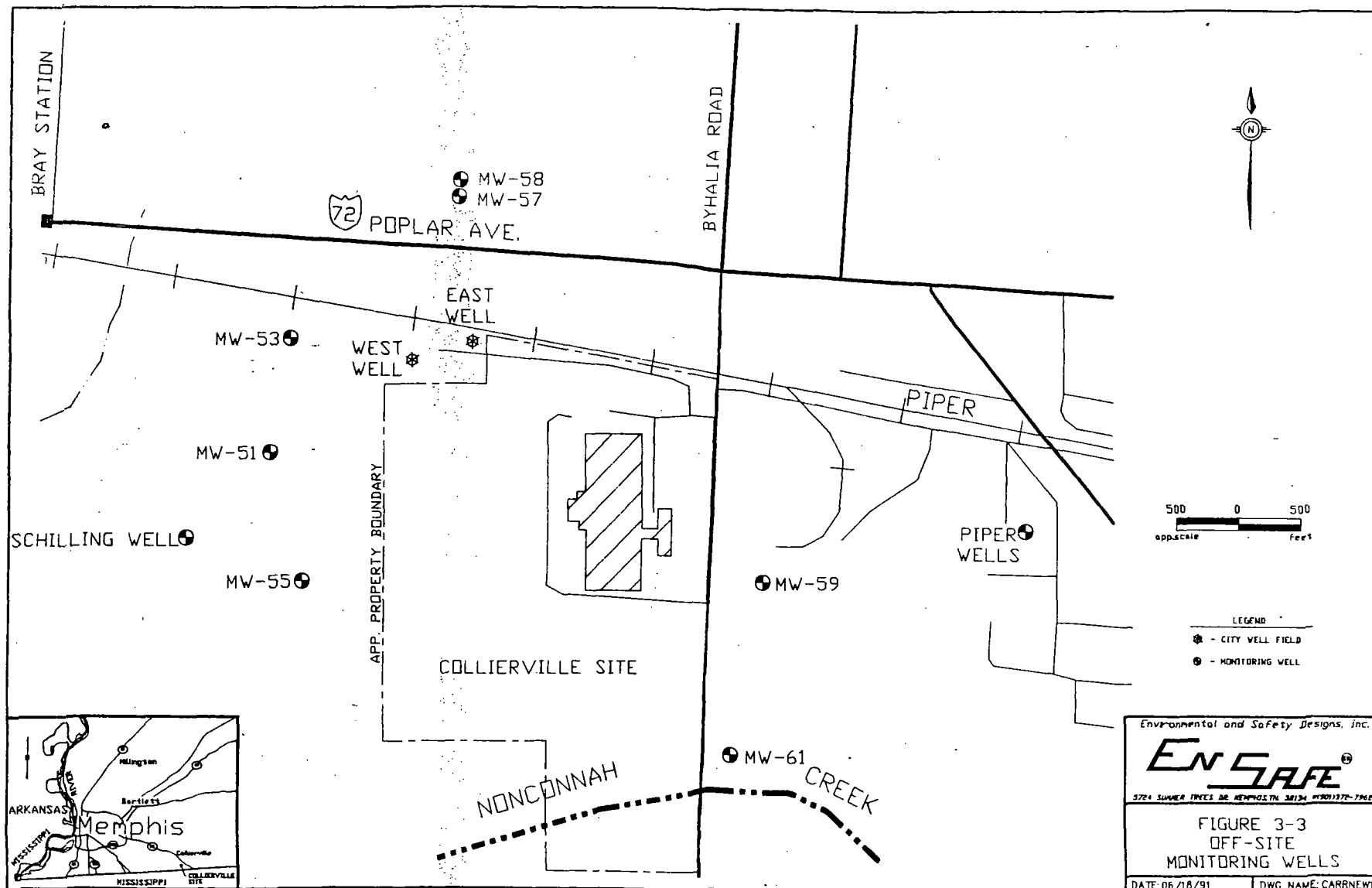
	Dec. 1989	April 1990	August 1990	Nov. 1990	Feb. 1991	April 1991	August 1991
MW-1	Sampled	Sampled	Sampled	Sampled	Sampled	Sampled	Sampled
MW-1A	Dry	Dry	Dry	Dry	Dry	Dry	Dry
MW-1B	Sampled	Sampled	Sampled	Sampled	Sampled	Sampled	Sampled
MW-3	Sampled	Sampled	Sampled	Sampled	Sampled	Sampled	Dry
MW-4	Sampled	Sampled	Sampled	Sampled	Sampled	Sampled	Sampled
MW-5	Sampled	Sampled	Sampled	Sampled	Sampled	Sampled	Sampled
MW-6	Sampled	Sampled	Sampled	Sampled	Sampled	Sampled	Sampled
MW-9	Dry	Dry	Dry	Dry	Dry	Dry	Dry
MW-10	Sampled	Sampled	Sampled	Sampled	Sampled	Sampled	Sampled
MW-11	Dry	Dry	Dry	Dry	Dry	Dry	Dry
MW-12	Sampled	Sampled	Sampled	Sampled	Sampled	Sampled	Sampled
MW-13	Sampled	Sampled	Sampled	Sampled	Sampled	Sampled	Sampled
MW-14	Sampled	Sampled	Sampled	Sampled	Sampled	Sampled	Sampled
MW-15	Dry	Dry	Dry	Dry	Dry	Sampled	Dry
MW-16	Sampled	Sampled	Sampled	Sampled	Sampled	Sampled	Sampled
MW-19	Dry	Sampled	Sampled	Sampled	Sampled	Sampled	Sampled
MW-21	Sampled	Sampled	Sampled	NRS	NRS	NRS	NRS
MW-23	Sampled	Sampled	Sampled	Sampled	Sampled	Sampled	Sampled

Table 3-4 (Cont.)
QUARTERLY SAMPLING EVENTS

	Dec. 1989	April 1990	August 1990	Nov. 1990	Feb. 1991	April 1991	August 1991
MW-25	NI	NI	Dry	Dry	Dry	Dry	Dry
MW-27	NI	NI	Sampled	Sampled	Sampled	Sampled	Sampled
MW-29	NI	NI	Sampled	Sampled	Sampled	Sampled	Sampled
MW-31	NI	NI	Sampled	Sampled	Sampled	Sampled	Sampled
MW-33	NI	NI	Dry	Sampled	Sampled	Dry	Sampled
MW-35	NI	NI	Sampled	Sampled	Sampled	Sampled	Sampled
MW-37	NI	NI	Sampled	Sampled	Sampled	Sampled	Sampled
MW-39	NI	NI	Sampled	Sampled	Sampled	Dry	Sampled
MW-41	NI	NI	Dry	Dry	Dry	Dry	Dry
MW-43	NI	NI	Dry	Dry	Dry	Dry	Dry
MW-47	NI	NI	NI	NI	NI	Dry	Sampled
MW-49	NI	NI	NI	NI	NI	Dry	Dry
MW-51	NI	NI	NI	NI	NI	Dry	Dry
MW-53	NI	NI	NI	NI	NI	Dry	Sampled
MW-55	NI	NI	NI	NI	NI	Dry	Dry
MW-57	NI	NI	NI	NI	NI	Sampled	Sampled
MW-58	NI	NI	NI	NI	NI	Sampled	Sampled
MW-59	NI	NI	NI	NI	NI	Sampled	Sampled
MW-61	NI	NI	NI	NI	NI	Sampled	Sampled

Note: Upon four (4) consecutive quarters of CLP analyses, reduced analytical protocols were implemented.





quarterly sampling event when sufficient groundwater was available. Bailing, sampling, and water level measurement procedures adhered to those guidelines set forth in the Region IV EPA SOP/QA Manual.

Samples were collected throughout the field investigation utilizing the following equipment:

Deep Wells:

Dedicated well pumps

QED Model T1200 Stainless Steel Pump with Teflon™ Bladder and Stainless Steel Inlet Screen; utilizing 3/8" Teflon™ coated tubing attached to a portable Pneumatic Controller.

Shallow Wells:

Dedicated Bailers

Teflon™ construction with Molded Caps and Threadless Joints; attached to a section of Teflon™ coated Stainless Steel Wire.

Phase I

During Phase I of the Remedial Investigation and the associated quarterly sampling event, groundwater samples were planned for collection from all eighteen site monitoring wells; consisting of ten (10) shallow and eight (8) deep monitoring wells. In accordance with the EPA approved Sampling Plan, groundwater samples were collected only from those wells with sufficient recharge and analyzed for full CLP TCL/TAL constituents.

Phase II

During Phase II of the RI and associated quarterly sampling events, groundwater samples were collected from all monitoring wells. Twelve (12) shallow wells completed in the fluvial terrace deposits, and eight (8) deep wells completed in the Memphis Sands. Eight (8) shallow wells had insufficient recharge for sampling. In addition, following completion of Phase II well installation activities, three remote wells were available for sampling to establish and further characterize background water quality (Section 7). Phase II samples were analyzed under CLP procedures for confirmed site constituents only.

Phase III

During Phase III of the RI and the subsequent quarterly sampling event, groundwater samples were collected from all monitoring wells which had sufficient recharge for sampling. A total of twenty-nine (29) shallow wells were completed in the fluvial terrace deposits, and nine (9) deep wells were completed in the Memphis Sands. Phase III samples were analyzed under CLP procedures for confirmed site constituents only.

3.4. Sampling Protocol

Containers

All sample containers supplied to EnSafe for the Phase I and Phase II field activities were precleaned by CompuChem Laboratories, Inc. in accordance with procedures specified in

the *CompuChem Standard Operating Procedures for Glassware Preparation*. All sample containers supplied to EnSafe for the Phase III field activities and all quarterly groundwater sampling events beginning in February of 1991 were precleaned by Pace Laboratories, Inc. in accordance with procedures specified in the *Pace Quality Assurance Plan*.

Sample containers for soil samples included four (4) ounce wide mouth glass VOA jars and eight (8) ounce clear glass wide mouth jars. One thousand (1000) ml clear glass jars were also used for soil collection during the Phase I investigation. Groundwater samples were collected in forty (40) ml amber glass vials, five hundred (500) ml plastic, and one thousand (1000) ml glass jars. All sample containers were equipped with Teflon™ lined lids.

Sample Preservation

In accordance with the EPA approved Sampling Plan specified groundwater samples required the addition of chemical preservatives. Designated samples were preserved immediately following collection. Each sample was clearly identified on both the sample label and tag as to the type of preservative used. All samples were chilled to approximately 4 degrees centigrade prior to and during shipment to the contract laboratory.

Sample Holding Times

Individual laboratory analyses were to be performed within specified holding periods from the time of sample collection. In order to meet these requirements, all samples collected at the Collierville Site were shipped via overnight delivery service to the contract laboratory; however, due to laboratory backlogs beyond the control of Carrier or EnSafe, specified holding times were missed on various samples and are further detailed in Section 4.

Sample Handling

Samples were handled as infrequently as possible following collection. Extreme care was taken to ensure that samples were not contaminated from external sources. A trip blank was included with each sample shipment and analyzed with the corresponding sample lot.

All samples were shipped utilizing "sample savers" supplied by the laboratories. These containers were designed to ensure maximum protection from handling and to maintain samples at 4 degrees C during shipment.

Chain-of-Custody

To assure that the samples were maintained in a safe and reliable manner, a strict chain-of-custody procedure was implemented for all samples collected from the Collierville Site. This was implemented in the field and carried out through the entire procedure. All parties handling/packaging the samples signed the chain of custody form. The form then became a part of the permanent record.

Auxiliary Data

Auxiliary data relative to sample locations were collected as close to sample collection time as possible. All auxiliary data was logged in bound field note books. These field records included all information about weather conditions and other activities that occurred during sampling events. Boring logs were maintained for all boreholes. Pumping rates and water level measurements were documented for all events involving the sampling of monitoring wells. In addition, the time of all events involved in the investigation were recorded.

3.5 Decontamination Procedures

To prevent cross contamination during the Phase I RI/FS, all equipment (sampling, drilling, mobilization, etc.) that was utilized during the investigation was decontaminated in accordance with the *EPA Region IV SOP/QA Manual* (SOP/QA Manual) dated April 1, 1986. All decontamination procedures took place in a specially constructed contained area. The containment basin was large enough to decontaminate all vehicles involved with the investigation of the Collierville Site (drill rig, mobilization vehicles, etc.). All waste water collected in the containment basin was pumped into 55 gallon steel drums and managed in accordance with TDHE regulations.

All sampling spoils were containerized in 55 gallon steel drums. These wastes included auger spoils from drilling and all disposable sampling equipment.

Sampling equipment such as the split spoon sampler, hollow stem augers, and any other reusable equipment that were utilized during the investigation followed a seven step decontamination procedure. The procedure was as follows:

- 1) Equipment was washed thoroughly with laboratory detergent (Alquinox) utilizing a portable steam cleaner. Brushes were used to remove encrusted soils.
- 2) Equipment was pressure washed thoroughly with hot tap water.
- 3) Equipment was rinsed thoroughly with deionized water.
- 4) Equipment was rinsed twice with isopropanol.
- 5) Equipment was rinsed thoroughly with organic free water and allowed to air dry.
- 6) Equipment was wrapped with aluminum foil when stored or transported. Clean plastic was used for the augers, casings, etc... after the equipment air dried.
- 7) Prior to arrival on site all downhole equipment was sandblasted. In addition, two times during the investigation selected augers were sandblasted due to the presence of sand grains which appeared to have fused to the augers. The additional sandblasting was conducted after the installation of MW-25 on July 24, 1991, and following the installation of MW-37 on July 27, 1991.

Field rinsing solutions were kept in stainless steel containers designated specifically for that solution. Solutions were changed between each individual sample location. When each solution was changed, the used solution was poured into 55 gallon steel drums marked specifically for that waste or the containment basin adjacent to the decontamination pad.

All waste water was collected during the decontamination procedure in a containment basin adjacent to the decontamination pad. Waste water was then pumped into DOT approved 55 gallon drums for proper disposal. All wastes were disposed of in accordance with all applicable federal and state laws.

3.6 Analytical Procedures and Quality Assurance

The EPA approved Quality Assurance Project Plan (QAPP) specified the analytical procedures for all sample media, as well as field and laboratory quality control. Extraordinary care in sample collection was implemented to prevent the loss of contaminants due to volatilization. The QAPP further specified adequate field and laboratory controls to establish that all criteria are met and are further detailed in Section 4.

4.0 HAZARDOUS SUBSTANCES

The Remedial Investigation approached the identification and quantification of hazardous substances on the Collierville Site in three (3) phases. Phase I consisted of a series of test borings in various locations on the site with analysis of selected samples for the Contract Laboratory Program (CLP) Target Compound and Target Analyte List (TCL/TAL); and collection of samples from pre-existing site monitoring wells, and the adjacent city water wells, with analysis of these samples for the same TCL/TAL compounds. This limited Phase 1 investigation was intended to establish the validity of prior studies which had suggested that trichloroethylene (TCE) and its degradation products were the site constituents of concern and to validate the levels of TCE found in these prior investigations. Upon this validation of prior data, Phases II and III were then conducted to fill recognized data gaps at the Site. Site specific work, sampling, health and safety, and quality assurance project plans were prepared and approved by USEPA prior to startup of RI activities. All activities were conducted in accordance with these plans.

4.1 Scope of Phase 1 - Data Validation Study

To ensure that data obtained in prior studies accurately represented Site conditions, a Data Validation Study was designed to confirm prior Site data. The study had three specific objectives:

- 1) Establish a Site Constituents List for the RI. Prior studies had assumed that TCE and its degradation products were the only Site constituents. To test this assumption, all soil and water samples collected in the Data Validation Study were analyzed for the CLP Target Compound and Target Analyte List.
- 2) Determine the acceptability of prior Site data for use in the RI. Prior studies had utilized non-CLP analytical methods and were not implemented with an EPA approved Quality Assurance Project Plan (QAPP).
- 3) Determine whether a field screening method developed for use in prior studies was sufficiently accurate and precise to be used in the RI.

Soil Sampling

Four borings were installed on the Site during the Phase 1 Data Validation Study. One boring was placed in each of the three suspected source areas. The fourth boring was placed in an area determined likely to be free of contamination by previous investigations. Split spoon samples were collected at eight foot intervals during drilling and sampling was terminated upon reaching the Jackson Clay confining stratum. These borings, identified as Borings 37 through 40, are located as shown on Figure 3-1 in the previous section.

The 24 soil samples obtained were split and analyzed by two different methods. One split of each sample was analyzed for target compounds and analytes using CLP protocols. The other split was analyzed by the field screening method. [This field screening method employs a co-distillation technique followed by GC analysis and is approved for chlorinated

solvent analysis by the U.S. Food and Drug Administration. It is fully described in the Collierville Site Quality Assurance Project Plan and in the Data Validation Study Report. Its primary advantage is the ability to obtain data within a few hours of sample collection.]

Groundwater Sampling

All preexisting site monitoring wells capable of producing sufficient sample for analysis were sampled during the Phase 1 work elements. This produced 13 groundwater samples from the Site. In addition, raw water was sampled from two municipal wells adjacent to the site (east and west wells). These samples were split for analysis. One split was analyzed using CLP methods for the full Target Compound and Analyte List while the other split was analyzed by EPA Method 624, which has typically been used in the prior Site investigations.

In some cases, monitoring wells produced insufficient sample for full TCL/TAL analysis. A summary of well sampling history is provided in Section 3, Table 3-4. In that event priority was given to volatiles because of the Site's TCE spill history. Many of the shallow wells were bailed dry prior to sampling. The ability of the shallow wells to produce sufficient sample quantity for analysis also varied with meteorologic conditions. Therefore, data is available on some of these wells in the winter quarter sampling but not for the summer quarter. Section 5 describes the aquifer characteristics which produce this variation in water recharge in the shallow aquifer.

4.2 Results of Phase 1 - Data Validation Study

Soil Data Comparison

Boring 37

Boring 37 was installed on the northern edge of the industrial plant in an area which previous investigators had assumed was not impacted by TCE. This boring was therefore intended to serve as a "background" for soil data and to confirm the assumption that the northern area of the property was not affected by TCE releases. The boring was advanced to 48 feet (to the top of the first confining layer). Samples were taken at 8 feet, 18 feet, 24 feet, 32 feet, 40 feet, and 48 feet. Neither TCE nor its degradation products was detected in any sample at a detection limit of 5 ppb. Both the CLP tests and the screening method tests were negative. No other volatile organic contaminants were identified, excepting compounds with "B" notations. Semi-volatiles were not detected except for "J" noted bis(2-ethylhexyl)phthalate. Pesticides and PCBs were also not detected.

Boring 38

Boring 38 was placed in an area identified from previous investigations as an area with elevated TCE in subsoils. This boring is near former Boring 9 on the southern side of the main plant in the area impacted by the 1979 spill of TCE. In previous investigations, TCE concentrations at the 10 foot level at Boring 9 were reported at 1,500,000 ppb. At 20 feet, TCE was reported at 6,300 ppb by the soil screening method. Boring 38 screening method data showed TCE at 10 feet to be 299,000 ppb. CLP data was 1,200,000 ppb at this depth. At lower depths, the CLP data was very low (1 to 6 ppb) while the screening method data

was 31-15100 ppb). The CLP data were also positive for 1,2-dichloroethylene (DCE). [Analyses for DCE were not performed in the screening method; therefore, a comparison cannot be made for DCE concentrations.]

The CLP data was also positive for certain other volatile hydrocarbons at the shallow depth. These compounds, xylene, tetrachloroethylene, and 1,1,1-trichloroethane, were not found in any other samples. This is consistent, however, with the reported spill of degreaser solvent which often contains small amounts of other solvents such as 1,1,1-trichloroethane and tetrachloroethylene.

Boring 39

Boring 39 was located on the east side of the property in the area impacted by a 1985 spill of TCE. Following that release, an investigation and remediation occurred which removed most of the TCE from soils. Both CLP and screening methods data were positive for TCE, but at lower concentrations than were encountered at Boring 38. CLP concentrations ranged from 5 to 87 ppb. Screening method concentrations were 53 to 122 ppb. The CLP method also reported trace DCE in two samples.

Boring 40

Boring 40 was placed in the old surface impoundment area previously investigated by Borings 17, 18, and 19. Samples from these borings were analyzed by the screening method in 1988, yielding TCE values at 18 feet of 10 - 930 ppb. At Boring 40, the screening method resulted in TCE of 114 at 18 feet. The CLP data showed no detectable TCE. At other depths, the screening procedure yielded higher concentration values than the CLP

Method, except for the bottom sample at which the CLP method reported 13,000 ppb and the screening method reported 1230 ppb.

Table 4-1 summarizes the relationship between the screening procedure and the CLP procedure on soil samples. The screening method is clearly providing higher concentrations than the CLP method and is further yielding TCE positive data when the CLP method reports none detected. It appears however that there may be a correlation between the methods within the range of 50 to 500 ppb. It has been concluded therefore that historical data from screening method analysis of prior borings can be used to confirm the absence of TCE, but should be used only cautiously to confirm the presence of the compound. However, the screening method should continue to be used concurrently with the CLP method to establish whether a relationship exists between the methods.

Groundwater Data Comparison

Validation of previous site groundwater monitoring data was assessed through concurrent analysis of split samples by both Contract Laboratory Program (CLP) Scope of Work and Method 624 protocols. Fundamentally, the two analytical procedures are identical. Differences in results reflect either variability in the split sample handling/analysis, or slight inter-method differences in administrative procedures. An example of the latter, and one likely explanation for discrepancy in higher level samples, is the required dilution of samples which saturate the instrument on first analysis. Under the CLP Statement of Work, the sample must be diluted and reinjected until response for the parameter in question is within instrument calibration range. In the case of Method 624, a single "educated guess" dilution

TABLE 4-1
COMPARISON OF SPLIT SOIL SAMPLES
CODISTILLATION vs. EPA CLP SOW METHODS

SAMPLE	1,2 Dichloroethene (total)		Trichloroethene, ppb			
	EPA CLP SOW		EPA CLP SOW		CODISTILLATION	
	FLAG	VALUE/LIMIT	FLAG	VALUE/LIMIT	FLAG	VALUE/LIMIT
B37-1	BDL	6	BDL	6	BDL	10
B37-2	BDL	5	BDL	5	BDL	10
B37-3	BDL	5	BDL	5	BDL	10
B37-4	BDL	5	BDL	5	BDL	10
B37-5	BDL	5	BDL	5	BDL	10
B37-6	BDL	6	BDL	5	BDL	10
B38-1		200	D	1200000		299000
B38-2	BDL	6	J	1		326
B38-3	BDL	6	BDL	6		15100
B38-4	BDL	5	BDL	5		31
B38-5	BDL	14	J	3		270
B38-6	BDL	6	BDL	6		45
B39-1		18		30		118
B39-2	J	1		69		122
B39-3	BDL	6		87		93
B39-4	BDL	5	BDL	5		53
B39-5	BDL	5	J	5		117
B39-6	BDL	5	BDL	5		76
B40-1		14	J	6		1890
B40-2	BDL	6	BDL	6		114
B40-3	BDL	5	BDL	5		21
B40-4	BDL	5	BDL	5		37
B40-5	BDL	5	BDL	5		80
B40-6	J	6	D	13000		1230

is run, with the estimate for the parameter calculated from the resulting response, irrespective of instrument calibration. This is most likely to manifest itself as an underestimate in concentration of TCE if the concentration is higher than the highest standard used for the method (usually 100 ppb for Method 624).

Results of the split sample analyses for trichloroethylene and its apparent degradation products are summarized in Table 4-2. Table 4-2 also displays the result of a linear regression analysis of the samples, with (CLP) results treated as the independent variable and Method 624 results as the complimentary dependent variable. The expected result is a linear correlation with slope of 1 and a small constant. The regressions shown in Table 4-2 were forced to use a constant of zero in calculating correlation coefficients, slope and standard errors of estimate.

Regression of data sets for all three primary volatile constituents was calculated. In the case of total 1,2 dichloroethene, results were calculated with and without discarding the highest level sample, from monitoring well 03. For 1,1 dichloroethene, it should be noted that both splits from monitoring well 21 required dilution and 1,1 dichloroethene was undetected at the reported levels of 25 and 50 ppb.

Although the sample sizes were relatively small, the resulting correlations and coefficients were good, with the expected outcome of underestimation with high concentration for Method 624. The results are graphically presented in Figures 4-1, 4-2, and 4-3 for TCE, 1,2 DCE, and 1,1 DCE respectively.

TABLE 4-2

COMPARISON OF SPLIT GROUNDWATER SAMPLES
METHOD 624 vs. EPA CLP SOW

DATA AS RECIEVED				COMPOUND, ppb		
POINT	SAMPLE	METHOD	MATRIX	TCE	1,2 DCE	1,1 DCE
EC	122089EC	CLP	WA	39	1	1
MW01	12218901	CLP	WA	520	78	1
MW03	12198903	CLP	WA	4400	5300	7
MW16	12208916	CLP	WA	1	1	1
MW21	12208921	CLP	WA	1800	290	50
EC	122089EC	624	WA	39	1	1
MW01	12218901	624	WA	520	78	1
MW03	12198903	624	WA	4000	3600	7
MW16	12208916	624	WA	1	1	1
MW21	12208921	624	WA	1300	240	25

TC

DELETING HIGH CONCENTRATION OUTLIERS				COMPOUND, ppb		
POINT	SAMPLE	METHOD	MATRIX	TCE	1,2 DCE	1,1 DCE
EC	122089EC	CLP	WA	39	1	1
MW01	12218901	CLP	WA	520	78	1
MW03	12198903	CLP	WA	4400	0	7
MW16	12208916	CLP	WA	1	1	1
MW21	12208921	CLP	WA	1800	290	0
EC	122089EC	624	WA	39	1	1
MW01	12218901	624	WA	520	78	1
MW03	12198903	624	WA	4000	0	7
MW16	12208916	624	WA	1	1	1
MW21	12208921	624	WA	1300	240	0

REGRESSION ANALYSIS: CLP DATA AS INDEPENDANT VARIABLE						
Regression Output:	DATA AS IS			DELETING HIGH CONCENTRATIONS		
	TCE	1,2 DCE	1,1 DCE	TCE	1,2 DCE	1,1 DCE
Constant	0	0	0		0	0
Std Err of Y Est	158.62103	24.84645	1.7843142		6.49436091	0
R Squared	0.9909282	0.999751	0.9705205	NOT	0.99609529	1
No. of Observations	5	5	5	NECESSARY	4	4
Degrees of Freedom	4	4	4		3	3
X Coefficient(s)	0.8837001	0.679757	0.5101880		0.83922116	1
Std Err of Coeff.	0.0331672	0.004680	0.0353208		0.02162553	0
Least square's X:	4000	5000	50		300	10
line: Y:	3534.8	3398.8	25.5		251.8	10.0

FIGURE 4-1: EPA CLP SOW vs. METHOD 624

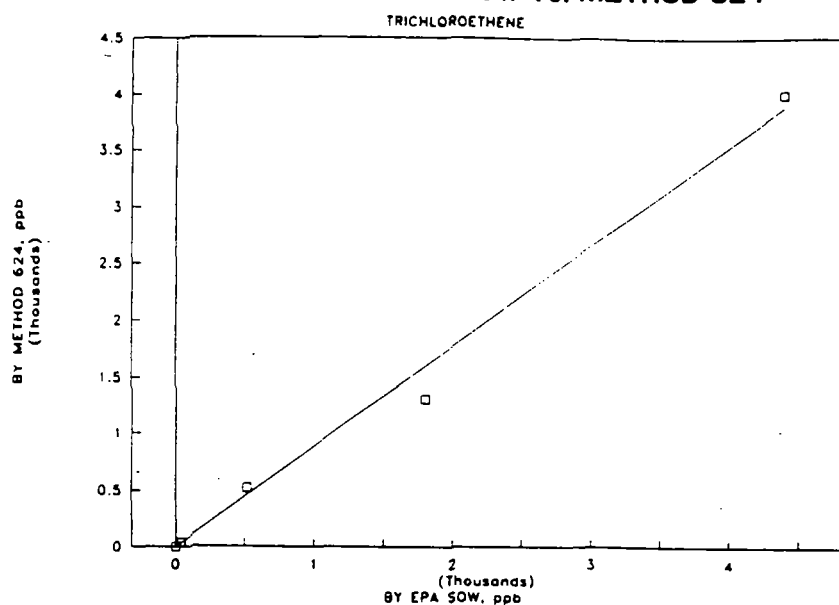


FIGURE 4-2: EPA CLP SOW vs. 624

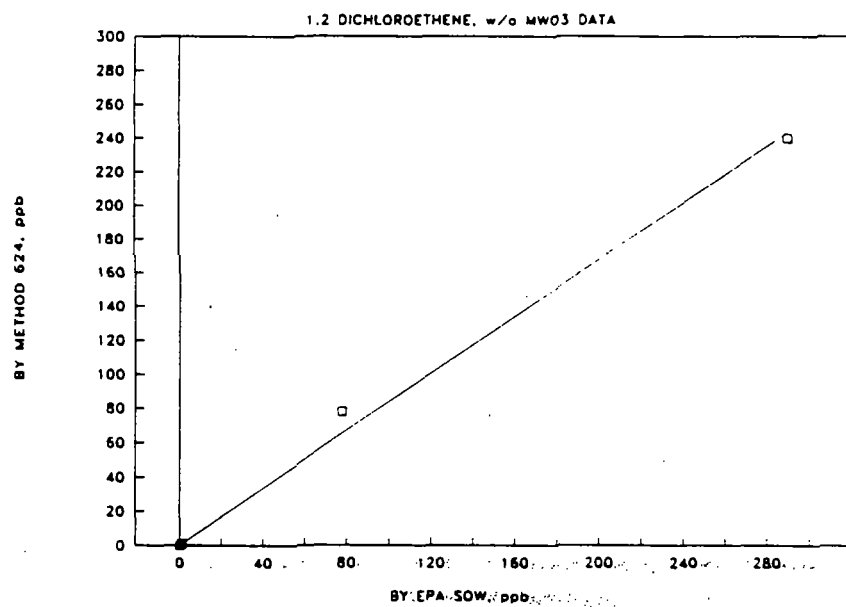
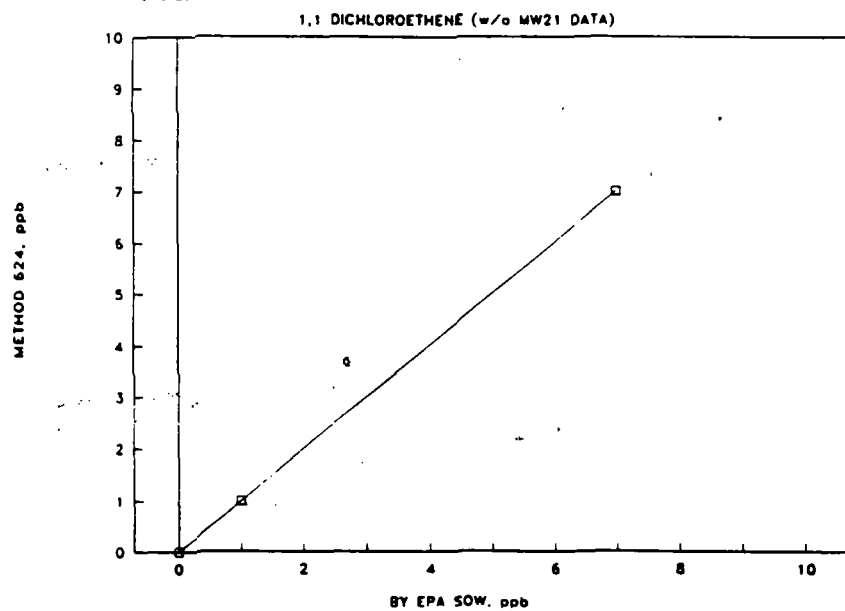


FIGURE 4-3: EPA CLP SOW vs. METHOD 624



Historically, Method 624 analysis of Site monitoring wells shows trends in these concentrations which agree with the recent CLP method "snapshot" of current concentrations. Tables showing historical monitoring well data are included in Appendix D at the back of this report.

The results of all soil samples are located in Appendices B and G. Results of groundwater analyses are located in Appendix H.

Phase 1 TCL/TAL analyses were evaluated in the Phase 1 report and accepted by EPA. Semivolatiles, pesticides, and PCBs were eliminated as potential Site constituents.

4.3 Data Quality

The overall quality of soil and groundwater data associated with the sampling and analysis at the Collierville Site is judged to be good and acceptable. Specific assessments of precision and accuracy are provided below.

Complete data sets have been transmitted under separate cover as part of monthly progress reporting on the site investigation and are not included here.

Traffic Reports

During Phase I samples were collected and shipped over a five day sampling period (December 18-22, 1989) and processed by the laboratory in three sample groups. The third sample group consisting of samples collected on December 22, 1989 (MW12, MW13,

MW14, and a field blank) were delayed by Federal Express and the holidays and therefore not received in the laboratory until December 27, 1990. Samples were however extracted and analyzed within holding time requirements.

Phase II sampling met all holding times specified in the QAPP except for the third quarter sampling of ground water during which three samples were held beyond allowable holding times by the project laboratory, CompuChem Laboratories, Inc. As a result of this failure and evidence that sample overloads would cause further failures and lead to delays in obtaining data, the project laboratory was changed to Pace Laboratories for the third quarter groundwater sampling event. Samples that exceeded holding times were recollected, and appear in Phase II Pace Laboratories groundwater data packages.

Fourth quarter 1990 groundwater samples met holding time requirements with the exception of samples requiring reanalysis. These samples were found to contain high concentrations of TCE and/or 1,2-DCE, and as a result, missed holding times should not compromise data quality.

First quarter 1991 groundwater samples met holding times with the exception of one (1) matrix spike/matrix spike duplicate set (022101-07A MS/MSD). The sample had been preserved with HCl, and as a result, the data were accepted because analysis was performed within 14 days of collection.

All Phase 3 soil samples (for which results have been received) met specified holding times.

Second quarter 1991 groundwater samples (for which results have been received) met holding times. A complete set of second quarter 1991 data was not available at the time this document was issued. This data will be addressed in a subsequent Monthly Progress Report.

Precision

For each analytical method used to analyze environmental samples, the variation in reported results that might be due to random differences in the handling and analysis of that matrix is referred to as the precision or reproducibility of the analysis. To demonstrate reproducibility, the CLP Statement of Work specifies the addition of known quantities of several compounds (5 volatile compounds and 11 semi-volatile compounds) to two aliquots of each matrix type. These "spiked" aliquots are then to be analyzed using exactly the same preparation and analytical methods as used for all other samples of that matrix type, analyzed by that method. These spiked aliquots are referred to as matrix spike (MS) and matrix spike duplicate (MSD).

For the Collierville Site sampling, matrix spikes and matrix spike duplicates were performed on groundwater and soil using low method analyses.

The groundwater volatile MS and MSD results were generally good. The levels of TCE exceeded the multi-point range due to the high levels present in the original sample with the addition of the spike amount. Thus the MS/MSD data, although acceptable, is qualified. In the groundwater semi-volatile analysis, the QC MS/MSD results were acceptable.

The soil analyses MS and MSD results also were generally good. However B38 was analyzed twice, once at low level and once at medium level. There are no medium level MS/MSD results due to the dilution required.

All fourth quarter 1990 groundwater MS and MSD results were within CLP guidelines. First quarter 1991 groundwater MS and MSD results were generally good. The %RPD values did not meet CLP criteria in two (2) samples from this set. For Sample 02891-37 MS/MSD, the DCE RPD value was in excess of 14% (18%), and as a result, the MS/MSD data has been qualified. High TCE concentrations in the original sample led to RPD values above CLP standards for MS/MSD Sample 021991-19. The high TCE concentrations can be attributed to TCE levels (with spike additions) exceeding the multi-point range as previously discussed, and as a result, this MS/MSD data has been qualified.

Second quarter 1991 groundwater MS and MSD results were generally good. The DCE RPD for one (1) MS/MSD set (Sample 042391-27) was above the acceptable value. As a result, the MS/MSD data has been qualified. Sample 041991CMW002 MS/MSD had four (4) RPD values outside control limits. The samples within the set did not contain any of the target compounds, and as a result, the data was accepted.

Phase 3 soil analysis precision was generally good. One (1) RPD value for chlorobenzene was outside control limits. However, since no aromatic compounds were identified in soil samples in this set, the data have been accepted.

Accuracy

Accuracy is the degree to which a given result agrees with a "true" value. To check accuracy in TCL analyses, the CLP Statement of Work requires the addition of known amounts of "surrogate compounds", compounds not likely to be present in the field, to the sample. If, upon analysis of a sample, the concentrations determined for surrogate compounds are accurate (i.e., close to the known concentrations as defined to be within limits specified by the CLP Statement of Work), the concentrations determined for TCL compounds are judged to be accurate.

Groundwater results exhibited several data accuracy problems which may be attributable to the high concentrations of specific analytes in the matrix. The Relative Percent Difference (RPD) value for TCE exceeded QC limits. In addition in the semi-volatile analyses, recoveries of 2,4-dinitrotoluene exceeded QC limits in the MS/MSD. Since no semi-volatile compounds were found, an excessive recovery is not deemed consequential. However, the large RPD for TCE may reflect data variability. The RPD for TCE was also exceeded in the analysis of B39 samples and B40 samples.

Volatile compound surrogate spike recoveries were within control limits for all samples in the following groups: Fourth Quarter 1990-Groundwater, First Quarter 1991-Groundwater, Second Quarter 1991-Groundwater (partial set), and Phase 3 soil samples (partial set). As a result, all data from these sampling events has been deemed accurate. Other QA/QC related items are discussed in the case narratives associated with the raw data packages which have been transmitted to EPA under separate cover during the RI.

External Quality Control

Three soil samples were provided to the sampling team during sampling of soils at the site. The samples were provided by the oversight contractor's representative and are presumed to contain known concentrations of specified parameters. Results are reported as B37-7, B37-8 and B49-11 to prevent the laboratory from recognizing the samples as "check" samples. Known or expected results have not been provided by EPA. Analytical results for B37-7 and B37-8 are shown in Appendix B. Analytical results for B49-11 are shown in Appendix G.

EPA also provided "check samples" for groundwater analyses. The results of these samples are presented in Appendix H as Samples numbers 08159002, 0815902A, and 0815902B. Phase III "check samples" included MW57-13, 02219107, 02219107A, 02219107B, 04249107, 04249107A, 04249107B. The analytical results have been included in Appendices G and H respectively.

Inorganic Data Quality

The inorganic (TAL) analyses for groundwater generally exhibited good analytical precision and accuracy. However, a number of soil samples showed problems related to poor reproducibility and inadequate recoveries. B37 and B39 TAL data are qualified with respect to zinc, chromium, manganese, aluminum and sodium due to high RPDs. Arsenic and lead are qualified as a result of poor recoveries on spikes.

The inorganic (TAL) analyses for groundwater samples collected during the fourth quarter of 1990, and the first and second quarters of 1991 generally exhibited good analytical precision and accuracy. With few exceptions, any analytical problems were restricted to parameters that are not Confirmed Site Constituents. In one (1) instance, spike recoveries were outside control limits for lead. Lead recovery was slightly below 75 % (73 %). One

(1) RPD value for lead was also outside control criteria, however, the associated samples were not found to contain lead above detection limits. As a result, the data was accepted.

4.4 Blank Analysis

Blank analyses provide an evaluation of decontamination procedure inadequacy, and the potential for sample cross-contamination. Blank analyses performed in conjunction with the Carrier Collierville site were generally good. The most frequent volatile compounds identified in field and rinsate blanks were methylene chloride, carbon disulfide, acetone, and 2-Hexanone. These compounds have been attributed to laboratory artifacts.

Tetrachloroethene was identified in a QC blanks; however, the tetrachloroethene appeared to be isolated to the blanks. As a result, the data associated with these blanks have been accepted. TCE was also identified in blanks. Sample TCE levels in associated data sets were generally well above QC sample concentrations. As a result, the data have been accepted.

Inorganic analytes identified in QC samples were generally unremarkable (with respect to Site constituents). Lead and/or zinc was identified in some field and rinsate blanks. In most instances, lead and zinc were also present in laboratory blanks, and as a result, the data have been qualified by the laboratory. Summaries of field and rinsate blank data are provided in Tables 4-3 and 4-4.

**TABLE 4-3
SUMMARY OF FIELD BLANK DATA**

SAMPLING DATE/ID	COMPOUND	CONCENTRATION
121989FB	Methylene Chloride	2J
121989FB	Toluene	3J
121989FB	Calcium	26.9B
121989FB	Copper	8.2B
121989FB	Magnesium	97.2BE
121989FB	Iron	24.7B
121989FB	Manganese	1.2B
121989FB	Potassium	1300B
121989FB	Silver	5.8B
121989FB	Vanadium	4.2B
121989FB	Zinc	23.4B
LABPURE121989	Methylene Chloride	2BJ
LABPURE121989	Toluene	2J
122089FB	Calcium	74.3
122089FB	Iron	110
122089FB	Lead	4.0
122089FB	Vanadium	2.1B
122089FB	Zinc	13.4B
122189FB	Iron	103
122189FB	Lead	2.7
122189FB	Magnesium	171BE
122189FB	Manganese	5.3B
122189FB	Potassium	4520B
122189FB	Sodium	2190B
122189FB	Vanadium	6.6B
122189FB	Zinc	3.5B

**TABLE 4-3
SUMMARY OF FIELD BLANK DATA**

SAMPLING DATE/ID	COMPOUND	CONCENTRATION
122289FB	Methylene Chloride	1J
122289FB	Chloroform	2J
122289FB	2-Butanone	3J
122289FB	Potassium	2720B
122289FB	Sodium	1540B
122289FB	Vanadium	5.0B
012390WS	Methylene Chloride	4J
LABPURE012390	Methylene Chloride	2J
051690FB	Calcium	27.2B
051590FB	Iron	5.4B
051690FB	Zinc	8.7B
051790FB	Toluene	1J
051790FB	Calcium	34.3B
051790FB	Iron	5.9B
051790FB	Zinc	13.7B
051890FB	Methylene Chloride	1J
051890FB	Toluene	1J
051890FB	Barium	16.7B
051890FB	Calcium	45.5B
051890FB	Zinc	19.0B
052290FB	Methylene Chloride	1J
052290FB	Tetrachloroethene	3J
052390FB	Methylene Chloride	3BJ

**TABLE 4-3
SUMMARY OF FIELD BLANK DATA**

SAMPLING DATE/ID	COMPOUND	CONCENTRATION
052390FB	Acetone	4J
052390FB	Carbon Disulfide	4J
052390FB	Chloroform	3J
052390FB	Tetrachloroethene	1J
052390FB	Toluene	4J
081590FB	Arsenic	1.5B
081590FB	Lead	1.1B
081690FB	Acetone	7J
081690FB	Arsenic	2.7B
081690FB	Chromium	9.0B
081690FB	Lead	1.2B
081790FB	Methylene Chloride	2J
081790FB	Carbon Disulfide	3J
081790FB	Chromium	7.0B
081790FB	Lead	0.80B
081790FB	Zinc	9.0B
082090FB	Arsenic	6.8B
082090FB	Lead	1.9B
082090FB	Manganese	4.0B
082090FB	Methylene Chloride	1J
082490FB	Acetone	30B
082490FB	Arsenic	1.5B
082490FB	Iron	51.0B
082490FB	Lead	2.8B

**TABLE 4-3
SUMMARY OF FIELD BLANK DATA**

SAMPLING DATE/ID	COMPOUND	CONCENTRATION
111390FB	Lead	0.60B
111390FB	Zinc	6.0B
111490FB	Lead	0.30 B ug/l
111490FB	Zinc	5.0B
111490FB	Methylene Chloride	2J
111490FB	Acetone	8BJ
111490FB	Tetrachloroethene	9
111590FB	Lead	0.60B
111590FB	Zinc	22.0
111590FB	Methylene Chloride	2J
111590FB	Acetone	5BJ
111590FB	Chloroform	0.8J
111590FB	2-Butanone	3J
111690FB	Lead	0.30B
111690FB	Zinc	BDL (<4.5)
111690FB	Methylene Chloride	2J
111690FB	Trichloroethene	3J
021891FB	Lead	0.60U
021891FB	Zinc	13.0B
021891FB	Methylene Chloride	5J
021891FB	Tetrachloroethene	27
021991FB	Lead	2.0B
021991FB	Zinc	127

**TABLE 4-3
SUMMARY OF FIELD BLANK DATA**

SAMPLING DATE/ID	COMPOUND	CONCENTRATION
021991FB	Methylene Chloride	4J
021991FB	Tetrachloroethene	3J
022091FB	Lead	1.7B
022091FB	Zinc	17.0B
022191FB	Lead	0.60U
022191FB	Zinc	17.0B
022191FB	Methylene Chloride	5J
022291FB	Lead	0.60J
022291FB	Zinc	67.0E
041991FB	Methylene Chloride	1J
042391FB	Acetone	12B
042491FB		ND
042991FB		ND
050191FB		ND
(624)		
111490-FB	Tetrachloroethene	12
111590FB	Tetrachloroethane	2.3
111690FB	Carbon Tetrachloride	1.0

TABLE 4-4
SUMMARY OF RINSATE DATA

SAMPLING DATE/ID	COMPOUND	CONCENTRATION
011790RS	Barium	5.1B
011790RS	Beryllium	1.8B
011790RS	Calcium	92.5B
011790RS	Cobalt	5.8B
011790RS	Iron	12.9B
011790RS	Lead	2.3B
011790RS	Magnesium	59.0B
011790RS	Vanadium	2.7B
011790RS	Zinc	4.6B
012290RS	Methylene Chloride	2BJ
012290RS	Barium	3.3
012290RS	Iron	161
012290RS	Magnesium	194B
012290RS	Manganese	1.2B
012290RS	Potassium	2030B
012290RS	Vanadium	4.3B
012290RS	Zinc	6.1B
071390RB	Methylene Chloride	1BJ
071390RB	Carbon Disulfide	84E
071390RB	Tetrachloroethene	9
072490RB	Methylene Chloride	2BJ
072490RB	Carbon Disulfide	52
072490RB	4-Methyl-2-Pentanone	2J
072490RB	Aluminum	129B

**TABLE 4-4
SUMMARY OF RINSATE DATA**

SAMPLING DATE/ID	COMPOUND	CONCENTRATION
072490RB	Calcium	119B
072490RB	Methylene Chloride	2BJ
072490RB	Tetrachloroethene	180
072490RB	Iron	66.9B
072490RB	Manganese	1.2B
072490RB	Sodium	703B
072490RB	Zinc	13.5B
072690RB	Aluminum	66.0B
072690RB	Calcium	73.2B
072690RB	Iron	19.6B
072690RB	Lead	2.1B
072690RB	Zinc	15.2B
080190RS	Carbon Disulfide	4J
080190RS	Chloroform	1J
080290RS	Methylene Chloride	1BJ
080290RS	Acetone	4BJ
080290RS	Aluminum	88.2B
080290RS	Calcium	60.2B
080290RS	Iron	14.3B
080290RS	Sodium	402B
080290RS	Zinc	9.8B
081790RS	Methylene Chloride	11
081790RS	Acetone	91
081790RS	Chloroform	0.9J
081790RS	Toluene	2J

**TABLE 4-4
SUMMARY OF RINSATE DATA**

SAMPLING DATE/ID	COMPOUND	CONCENTRATION
081790RS	Iron	116
081790RS	Lead	6.2
081790RS	Zinc	82.0
082490RS	Aluminum	36.0B
082490RS	Arsenic	1.2B
082490RS	Cadmium	3.0B
082490RS	Chromium	8.0B
082490RS	Copper	8.0B
082490RS	Iron	75.0B
082490RS	Lead	2.4B
082490RS	Cyanide	9.0B
111690RS	Lead	0.30B
111690RS	Zinc	BDL (<4.5)
111690RS	Methylene Cholride	2J
021991RB	Lead	1.8B
021991RB	Zinc	49.0
032291RB	Lead	0.60U
032291RB	Zinc	89.0
032291RB	Acetone	9J
032291RB	2-Hexanone	2J
032291RB	Tetrachlorethene	65
032991RB	Lead	1.2B
032991RB	Zinc	16.0B
032991RB	Acetone	20

TABLE 4-4 SUMMARY OF RINSATE DATA		
SAMPLING DATE/ID	COMPOUND	CONCENTRATION
040191RB		ND
041291RD	Methylene Chloride	5BJ
041991RB		ND
Method 624		
111690RS		ND

4.5 Site Constituents

Tables 4-5 through 4-11 summarize the contaminants found in soil and groundwater on the Collierville Site and other areas investigated as part of the RI. These data confirm the earlier assumption that trichloroethylene (TCE) and 1,2-dichloroethylene, total (DCE) are the Site constituents of concern. The data also show that zinc and lead are present in groundwater although the source of these metals has not been identified. Occasional positive values for methylene chloride, acetone, and other volatiles were observed; however, there are no Site conditions which could explain the existence of these compounds. These contaminants have been attributed to laboratory artifacts.

The inorganic data for Phase I was less clear. The inorganic data for Borings 37 through 40 appeared to be consistent with generally accepted background levels for metal species. (Fitchko, 1989). However values for lead and zinc in shallow groundwater exhibited a wide range of values from near detection limit to values which exceed MCLs. (Groundwater from deep wells and the Town of Collierville wells did not show this range (Table 4-12). Metals in these wells are generally low and/or near reported background levels (Table 4-7). It has been reported that lead and zinc concentrations in shallow aquifers in West Tennessee exhibit this wide range. (Reference personal communication, Holland). The higher values may represent excessive soil leaching due to low pH groundwater or high values in soil generally. Groundwater pHs on the Collierville Site range from 5.2 to 6.8 and the water has been reported as being very "aggressive." (Reference Layne Central report). These factors suggested that metals were not likely site constituents. However further data were needed

to definitely establish whether the Site values were typical of "background" or a result of Site conditions. To achieve this additional data, three shallow wells were installed in offsite locations in Collierville. These wells are shown in Figure 3-2. Data from the three background wells and onsite shallow wells are summarized in Table 4-13. Full data tables for analysis of these wells are located in Appendix H.

Although zinc phosphate has been used on the Site and placed in the former surface impoundment, the data do not show a pattern of lead or zinc in association with TCE source areas nor is a pattern of contamination present.

There are several possible explanations, discussed below, for the lead and zinc values noted in Collierville Site data. However, due to the uncertainty associated with these metals, they are included as site constituents and are therefore evaluated in the Baseline Risk Assessment.

In soils, lead values range from 7 to 15 mg/kg in shallow soils. Average lead values decrease with depth in virtually all site soils except at the former lagoon area. Zinc values show a similar pattern. Thus lead and zinc soil concentrations may result from diverse anthropogenic sources unrelated to the TCE releases onsite.

Table 4-5
Summary of Soil Contaminants (ug/kg)
(All Phases)

PARAMETER	SAMPLING PERIOD/ PHASE	# SAMPLES	# HITS	RANGE	MEAN	STANDARD DEVIATION
TRICHLOROETHYLENE	ALL	56	8	8-1,200,000	152000	420000
1,2 DICHLOROETHENE	ALL	56	3	14-200	78	110
TETRACHLOROETHENE	ALL	56	1		11	
1,1,2 TRICHLOROETHANE	ALL	56	1		26	
TOLUENE	ALL	56	4	6-87	40	60
2 BUTANONE	ALL	56	1		190	
ACETONE	ALL	56	3	12-35	26	13
LEAD(mg/kg)	ALL	39	33	0.67-21.4	7	4
ZINC(mg/kg)	ALL	39	26	3.3-77.8	33	15

TABLE 4-6
Summary of Volatile Parameters (ug/liter) in
On-Site Monitoring Wells

Parameter	Sampling Period/Phase	No. Samples	No. Hits	Range (ppb)	Mean (ppb)	Standard Deviation
TRICHLOROETHYLENE	12/89	15	10	38-4400	1230	1700
	4/90	17	10	9-14000	2800	4800
	8/90	20	12	20-24000	3850	6800
	11/90	25	13	23-7300	1840	2800
	2/91	23	9	59-8700	2350	3400
	4/91	23	11	8-12500	4400	—
	8/91	25	15	5-37000	3800	—
1,2-DICHLOROETHENE	12/89	15	7	7-5300	1530	2400
	4/90	17	6	50-5400	2720	2400
	8/90	20	8	5-3900	830	1300
	11/90	25	9	8-12000	1480	4000
	2/91	23	9	11-12000	1560	3900
	4/91	23	7	7.2-6900	1200	—
	8/91	25	7	3-370	125	—
1,1-DICHLOROETHENE	11/90	25	2	9-14	12	4
	2/91	23	1	—	7.9	—
	4/91	23	1	—	4.75	—
	8/91	25	1	—	9	—
1,1,1-TRICHLOROETHANE	12/89	15	1		44	
	4/90	17	0			
	8/90	20	0			
	11/90	25	1		120	
	2/91	23	1		32	
	4/91	23	2	135.2-824	480	—
	8/91	25	1	—	69	—
TETRACHLOROETHENE	12/89	15	0			
	4/90	17	0			
	8/90	20	0			
	11/90	25	0			
	2/91	23	1		27	

TABLE 4-6
Summary of Volatile Parameters (ug/liter) in
On-Site Monitoring Wells

Parameter	Sampling Period/Phase	No. Samples	No. Hits	Range (ppb)	Mean (ppb)	Standard Deviation
METHYLENE CHLORIDE	12/89	15	0			
	4/90	17	2	7-160	85	110
	8/90	20	0			
	11/90	25	1		7	
	2/91	23	2	27-35	31	6
	4/91	23	6	8-997	210	—
	8/91	25	7	3-11	6	—
ACETONE	12/89	15	2	200-320	260	160
	4/90	17	6	12-860	450	350
	8/90	20	0			
	11/90	25	1		6	
	2/91	23	8	7.2-156	45	60
	4/91	23	4	3.2-790	250	—
	8/91	25	5	9.1-50	24	—

TABLE 4-6 (cont.)

Parameter	Sampling Period/Phase	No. Samples	No. Hits	Range (ppb)	Mean (ppb)	Standard Deviation
CARBON DISULFIDE	12/89	15	0			
	4/90	17	3	9-75	34	36
	8/90	20	0			
	11/90	25	3	7-58	24	30
	2/91	23	2	11-78	45	50
	4/91	23	1	—	17.1	—
	8/91	25	1	—	11	—
VINYL CHLORIDE	11/90	25	2	1-5	3	3
	2/91	23	1		3.4	
	4/91	23	2	2.27-8.51	5.5	—
	8/91	25	0	—	—	—
TOLUENE	11/90	25	1		5	
	4/91	23	0	—	—	—
	8/91	25	1	—	7	—
1,2-DICHLOROETHANE	2/91	23	1		43	
TRANS-1,3-DICHLOROPROPENE	2/91	23	1		46	
	4/91	23	0	—	—	—
	8/91	25	1	—	7.4	—
BROMODICHLOROMETHANE	2/91	23	1		42	
DIBROMODICHLOROMETHANE	4/91	23	1	—	824	—
CIS-1,3-DICHLOROPROPENE	2/91	23	1		37	
BROMOCHLOROMETHANE	2/91	23	1		48	

Table 4-7
Summary of Metals Results (ug/liter) in
On-Site Monitoring Wells

PARAMETER	SAMPLING PERIOD/ PHASE	# SAMPLES	# HITS	RANGE	MEAN	STANDARD DEVIATION
LEAD	12/89	15	3	4-106	42	60
	4/90	16	9	2.4-152	43	60
	8/90	20	20	1.4-54.2	19	30
	11/90	25	21	1.1-278	30	70
	2/91	26	11	4.9-198	50	60
ZINC	12/89	15	14	2.2-21900	4010	6300
	4/90	16	15	20.6-30300	6800	10000
	8/90	20	19	11-19800	4840	5500
	11/90	25	21	12-146,000	11650	32000
	2/91	26	24	10-30500	5600	8400

Table 4-8
Summary of Groundwater Parameters (ug/liter) in
Background Monitoring Wells

PARAMETER	SAMPLING PERIOD/ PHASE	# SAMPLES	# HITS	RANGE	MEAN	STANDARD DEVIATION
LEAD	8/90	3	3	4.3-39.5	22	18
ZINC	8/90	3	3	5.0-1580	990	860

NOTE: No TCE, DCE, or vinyl chloride in any of (3) background monitoring wells

Table 4-9
Summary of Nonconnah Creek Sediment Sample
Contaminant Parameters (mg/kg)

PARAMETER	SAMPLING PERIOD/ PHASE	# SAMPLES	# HITS	RANGE	MEAN	STANDARD DEVIATION
LEAD	6/90	2	2	18.3-23.2	21	4
ZINC	6/90	2	2	29.3-50	40	15

NOTE: No TCE, DCE, or vinyl chloride in TWO (2) SAMPLES

Table 4-10
Summary of Collierville Municipal
Well Water Results (ug/liter)

PARAMETER	SAMPLING PERIOD/ PHASE	# SAMPLES	# HITS	RANGE	MEAN	STANDARD DEVIATION
TRICHLOROETHYLENE	8/90	6	3	2-27	13	13
	11/90	6	2	34-45	40	8
1,2 DICHLOROETHENE	8/90	6	0			
	11/90	6	0			
VINYL CHLORIDE	8/90	6	0			
	11/90	6	0			
LEAD	8/90	6	6	1.2-7.6	4	2
	11/90	6	1		3	
ZINC	8/90	6	6	10-272	57	96
	11/90	6	5	11-115	56	40

Table 4-11
Summary of
Private Well Water Sample Results (ug/liter)

PARAMETER	SAMPLING PERIOD/ PHASE	# SAMPLES	# HITS	RANGE	MEAN	STANDARD DEVIATION
LEAD	2/91	2	0			
ZINC	2/91	2	2	270-289	280	14

NOTE: No TCE, DCE, or Vinyl chloride in ten (10) samples 5/90. No metals data.

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Collierville Site
Revision B
June 24, 1991

TABLE 4-12
COMPARISON OF LEAD AND ZINC VALUES
COLLIERVILLE SITE DEEP WELLS

WELL ID	LOCATION	LEAD μg/l	ZINC μg/l
MW-1	SE OF PLANT	5.3	212
MW-1	SE OF PLANT	2.4 B	5120
MW-4	SOUTH OF PLANT	41.4	17500
MW-6	WEST OF PLANT	2 U	2800
MW-10	EAST OF PLANT	5.3	205
MW-12	NORTH OF PLANT	2 U	24.9
MW-14	WEST OF PLANT	2 U	286
MW-16	SOUTH OF PLANT	2 U	3340

NOTE: Data from May 16, 1990 sampling event

TABLE 4.13
COMPARISON OF LEAD AND ZINC VALUES
BACKGROUND WELLS AND SHALLOW SITE MONITORING WELLS

WELL IDENTIFICATION	LOCATION	LEAD µg/l	ZINC µg/l
BACKGROUND WELL CWM-001	HIGHWAY 72	4.3	5.0
BACKGROUND WELL CWM-002	SHELTON ROAD	20.3	1580
BACKGROUND WELL CWM-003	POWELL ROAD	39.5	1380
MW-3	BYHALIA ROAD	7.8	8430
MW-5	SW SIDE OF PLANT	22.5	4890
MW-13	NW SIDE OF PLANT	1.5	11
MW-19	SURFACE IMPOUNDMENT	38.8	19800
MW-21	SURFACE IMPOUNDMENT	118	9440
MW-23	NW SIDE OF BUILDING	54.2	14400
MW-27	NE OF BYHALIA ROAD	44	4270
MW-29	E OF BYHALIA ROAD	9.4	5200
MW-31	SE OF BYHALIA ROAD	21.5	1020
MW-35	SW OF "A" BUILDING	8.7	776
MW-37	SW OF IMPOUNDMENT	5.4	117
MW-39	W OF CITY WELL FIELD #2	5.9	390

NOTE: Data from August 1990 sampling event.

In shallow groundwater, there is a possible pattern associated with well construction materials. Most site wells are constructed using galvanized casings with stainless steel screens. Phase II wells also have 10 foot stainless steel riser sections between the screen and casing. Wells in which the water elevation is higher than the stainless portion generally show elevated lead and zinc. Condensation in these and all wells is also a mechanism by which zinc and lead may be leached from well casings into groundwater being sampled. The possible leaching of lead and zinc from galvanized metal casings at the Collierville Site may also correlate with groundwater pH values which are very low in shallow groundwater and near neutral in the deep aquifer. The deep aquifer values for lead and zinc are very low.

Tables 4-14 and 4-15 provide a summary of soil lead and zinc data for four (4) on-site soil sampling locations and one (1) off-site background location. Data presented in Table 4-14 show that soil lead concentrations varied widely between locations and sampling depths at each location. No pattern for soil lead contamination is indicated by these data. In addition, there are no known sources for lead contamination related to site activities. Therefore, soil lead levels observed on-site are a function of naturally occurring concentrations, and are not attributable to present or former site activities.

TABLE 4-14
SOIL LEAD CONCENTRATIONS (mg/kg)
ON-SITE VERSUS BACKGROUND SAMPLES

Boring	Sampling Location	Sample Depth Interval (interval x 5 feet=depth)					
		1	2	3	4	5	6
37	Northeast of Plant approximately 125 ft.	11.0	4.5	22	1.7	1.6	4.0
38	South (center) of Plant approximately 15 ft.	15.8	8.7	9.7	1.7	11.7	5.8
39	Southeast Corner of Plant	11.9	21.4	5.9	1.3	1.5	1.5
40	Middle of Former Lagoon Area	7.0	6.1	3.6	2.1	2.4	14.6
55	Schilling Property (off-site) Background	15.1	8.1	6.9	2.2	2.1	5.0
Depth Interval Mean Value		12.2	9.8	5.7	1.8	3.9	6.2
Depth Interval Standard Deviation		3.5	6.7	2.9	0.4	4.4	5.0
95% Confidence Interval		± 2.0	± 5.9	± 2.6	± 0.3	± 3.9	± 4.4

Note: The above referenced sample locations were used in order to assess soil lead concentrations throughout the entire profile.

TABLE 4-15
SOIL ZINC CONCENTRATIONS (mg/kg)
ON-SITE VERSUS BACKGROUND SAMPLES

Boring	Sampling Location	Sample Depth Interval (interval x 5 feet=depth)					
		1	2	3	4	5	6
37	Northeast of Plant approximately 125 ft.	20.2	11.3	15.3	11.8	17.2	6.2
38	South (center) of Plant approximately 15 ft.	72.2	31.4	39.0	4.5	45.3	44.7
39	Southeast Corner of Plant	77.8	38.8	18.6	5.3	10.8	9.2
40	Middle of Former Lagoon Area	33.9	11.7	9.9	9.5	33.7	48.1
55	Schilling Property (off-site) Background	53.2	26.6	22.9	12.2	8.6	14.8
Depth Interval Mean Value		51.5	24	21.1	8.7	23.1	24.6
Depth Interval Standard Deviation		24.5	12.2	11.1	3.6	15.8	20.2
95% Confidence Interval		± 21.5	± 10.7	± 9.7	± 3.1	± 13.8	± 17.7

Note: The above referenced sample locations were used in order to assess soil zinc concentrations throughout the entire profile.

Soil zinc concentrations are shown in Table 4-15. As was the case with soil lead, no pattern of soil zinc contamination is indicated by the data. In areas where soil zinc concentrations regularly exceed the 95 % confidence level for the mean (Boring 38), there is no reason to suspect that present or former site activities have contributed to soil zinc concentrations (no apparent source). As a result, soil zinc concentrations observed onsite have been attributed to naturally occurring soil zinc.

4.6 Hazardous Substance Characteristics and Behavior

The various chemical and physical properties of Collierville Site constituents are shown in Table 4-16. These parameters provide an indication of environmental mobility of these compounds (Agency for Toxic Substance and Disease Registry, 1988). The relevance of these parameters is discussed below.

Water solubility provides an indication of the potential for contamination of and migration in water. In particular the rate at which a chemical is leached will be dependent on its water solubility. The water solubilities of the Site constituents are sufficiently high to pose a potential threat to groundwater and surface water. Soil affinity will reduce mobility to TCE and DCE in water. The soil-water partition coefficient is used as a gauge of such mobility, and can be experimentally estimated (see below).

Vapor pressure provides an indication of the rate at which a chemical volatilizes from soil or water into the air and affects the rate of volatilization from soil and water matrices.

TABLE 4-16
PHYSICAL AND CHEMICAL CHARACTERISTICS OF
TRICHLOROETHYLENE AND DICHLOROETHYLENE ISOMERS^{A,B}

PROPERTY/PARAMETER ¹	TRICHLOROETHYLENE	1,2-cis-DICHLOROETHYLENE	1,2-trans-DICHLOROETHYLENE
Molecular Weight	131.5	97.0	97.0
Solubility in Water(S),mg/l	1100	800	600
Vapor pressure (p ₀), torr	58	200	326
Sediment/water partition coefficient (k _{oc}), ml/g	126	NA	59
Density (d), g/cm ³	1.46	1.28	1.26
Boiling point(BP), °C	87	60	48
Abs viscosity (v), cp	0.57	0.48	0.40
Kin viscosity (v), cp	0.39	0.38	0.32
Henry's Law Constant (H), atm-m ³ /mol	0.0071	0.0029	0.072
Vapor density, RVD	1.27	1.62	2.01
Partition coefficient (log), octanol-water	2.42	N/A	N/A

Conversion Factors:

Air 1 mg/m³ = 0.18 ppm
1 ppm = 5.46 mg/m³
Water 1 ppm (w/v) = 1 mg/L

Identification Numbers for
Trichloroethylene

CAS Registry No:	79-01-6
NIOSH RTECS No:	KX4550000
EPA Hazardous Waste No:	U228
OHM-TADS No:	7216931
DOT/UN/NA/IMCO No:	UN 1710
National Cancer Institute	NCI-C04546

^A- Agency for Toxic Substances and Disease Registry (ATSDR), Toxicological Profile for Trichloroethylene, Draft 1988.

^B- Verschueren, Karel. "Handbook of Environmental Data on Organic Chemicals", 2nd Edition, Van Nostrand Reinhold-New York, 1983.

TABLE 4-16
PHYSICAL AND CHEMICAL CHARACTERISTICS OF
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PROPERTY/PARAMETER ²	TRICHLOROETHYLENE	1,2-cis-DICHLOROETHYLENE	1,2-trans-DICHLOROETHYLENE
Molecular Weight	131.5	97.0	97.0
Solubility in Water(S),mg/l	1100	800	600
Vapor pressure (p ₀),torr	58	200	326
Sediment/water partition coefficient (k _{oc}),ml/g	126	NA	59
Density (d), g/cm ³	1.46	1.28	1.26
Boiling point(BP),°C	87	60	48
Abs viscosity (v), cp	0.57	0.48	0.40
Kin viscosity (v), cp	0.39	0.38	0.32
Henry's Law Constant (H), atm-m ³ /mol	0.0071	0.0029	0.072
Vapor density, RVD	1.27	1.62	2.01
Partition coefficient (log), octanol-water	2.42	N/A	N/A

Conversion Factors:

Air 1 mg/m³ = 0.18 ppm
1 ppm = 5.46 mg/m³
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National Cancer Institute	NCI-C04546

^A- Agency for Toxic Substances and Disease Registry (ATSDR), Toxicological Profile for Trichloroethylene, Draft 1988.

^B- Verschueren, Karel. "Handbook of Environmental Data on Organic Chemicals", 2nd Edition, Van Nostrand Reinhold-New York, 1983.

- A- Agency for Toxic Substances and Disease Registry (ATSDR), Toxicological Profile for Trichloroethylene, Draft 1988.
- B- Verschueren, Karel. "Handbook of Environmental Data on Organic Chemicals", 2nd Edition, Van Nostrand Reinhold-New York, 1983.

High vapor pressures indicate high rates of volatilization. Vapor pressure is therefore a particularly important parameter at matrix interfaces such as soil/air, water/air, and waste/air. The Collierville Site constituents have relatively high vapor pressures compared to water.

Henry's law constant is the ratio of vapor pressure and water solubility and is used to calculate the equilibrium contaminant concentrations in vapor vs water phases. Henry's law constants indicate the potential success of aeration as a remediation technique.

The Collierville Site constituents have high Henry's law constants indicating high potential for aeration.

The **octanol/water partition coefficient** is used to estimate bioconcentration in aquatic organisms. It is assumed that there is a linear relationship between the octanol/water partition coefficient and the uptake of chemicals by the lipid tissue of animal and human receptors. Collierville Site constituents generally have low octanol/water partition coefficients, indicating a low potential for biologic uptake.

The **normalized distribution coefficient (k_{oc})** of a chemical is related to its water solubility and octanol/water partition coefficient. The k_{oc} indicates the relative tendency of a chemical to bind to soil organic carbon. Chemicals with high distribution coefficients are relatively immobile in the subsurface environment. However, they may still be easily transported by air/vapor and water migration. By multiplying a specific chemical's k_{oc} by the organic carbon factor of a soil, the **partition coefficient (k_d)** of a chemical in a specific soil may be determined. The k_d computed in this manner indicates the relative tendency of the chemical to bind to a particular soil matrix as opposed to remaining in the soil aqueous phase.

The **soil/water partition coefficient** relates equilibrium concentration of constituents in a soil matrix in contact with water. Given that in the environment, water infiltration through soil pores is slow relative to constituent mass transfer, the equilibrium relationship can be used to predict contaminant migration between phases. Soil/water partition coefficients are easily determined for the soil characteristic of a site through laboratory experiments.

Soil partition coefficients (K_d) are influenced significantly by the organic carbon fraction of soils. As a result, studies are currently in progress to determine whether sufficient organic carbon exists in Site soils to make contaminant adsorption a significant factor in overall attenuation.

4.7 References

Agency for Toxic Substances and Disease Registry (ATSDR), Toxicological Profile for Trichloroethylene, Draft, 1988.

Holland, Richard, Tennessee Division of Superfund, Jackson, TN. Personal Communication, September 30, 1990.

Layne Geosciences, Inc., Phase 1 Report, Shelton Road Well Field Study, Collierville, TN., April, 1989. (This study was conducted as part of a siting investigation for an additional well field for Collierville.)

Fitchko, J. Criteria for Contaminated Soil/Sediment Cleanup, Northbrook, IL: 1989

Verschueren, Karel. Handbook of Environmental Data on Organic Chemicals. Van Nostrand Reinhold- New York, 1983.

5.0 HYDROGEOLOGIC INVESTIGATION

The following section addresses two areas of contamination - soils and groundwater. The soil investigation consisted of a series of strategically placed borings. The groundwater phase consisted of the installation and sampling of both shallow (alluvial) and deep (Memphis Sand) monitoring wells.

5.1 Sampling Objectives

The RI Sampling Plan proposed to collect and analyze soil and groundwater samples to further characterize the Site. Characterization included the following objectives:

- 1) to describe the geology and hydrogeology specific to the Collierville Site; and,
- 2) to determine the nature and extent of contamination in Site soils and groundwater.

5.2 Summary of the Field Investigation

Three potential sources of TCE contamination were identified at the Carrier plant as discussed in Section 1.0: the 1979 spill site southwest of the main plant; the 1985 spill south of the plant office; and a third location, near the main plant; the former clarifier sludge impoundment. Possible additional locations of contamination were also considered during the investigation. No additional source areas were defined.

To determine the areal extent of contamination and to collect geological data on the site eighty-seven (87) soil borings have been performed. Forty (40) borings were completed as monitoring wells, thirty seven (37) at the Collierville Site and three (3) background wells elsewhere within the Collierville city limits.

5.2.1 Soil Borings

Soil borings were completed in multiple phases during the investigation, initially forty eight (48) soil borings were installed near each of the three potential source sites (13 completed as monitoring wells).

The initial soil borings were drilled to a depth of 20 feet with samples collected for TCE analysis at the surface and at 5 foot increments using a split spoon sampling device. Three borings (B-1, B-3, and B-26) were placed within the confines of the main plant facility. The remaining borings were sited in and near source areas and randomly west of building A and the southeast parking lot to achieve the investigation's objectives delineating the contaminated area.

Later borings were installed to the top of the underlying aquitard because of evidence from monitoring wells that TCE had migrated to the first saturated zone. These deeper borings were numbered B-21, B-24, B-26, B-27, B-30, B-36 through B-49. Plate 1 in the packet at the rear of this report identifies the locations of all soil borings conducted during the investigation.

In addition, permeability tests were performed from core samples collected of loess and the upper confining layer stratum. Samples were collected utilizing thin walled Shelby tubes

during the field investigation. The results of the permeability tests ranged from a value of 4.4×10^{-7} cm/sec. to 2.5×10^{-8} cm/sec and are included in Appendix E.

Values obtained are characteristic of low plasticity clays for the loess. Those Shelby tubes taken from the top of the Jackson-upper Claiborne are characteristic of high plasticity clays representative of the Jackson Formation.

5.2.2 Monitoring Wells

A groundwater monitoring system was installed at the Collierville Site to facilitate groundwater sampling and water level measurements. The well system at the Site consists of twenty eight (28) shallow wells screened in the shallow alluvium and nine (9) deeper wells screened within the Memphis Sand (Figure 3-2). All shallow wells are designated with odd numbers (i.e. MW-3). All deep wells are identifiable by even numbers (i.e. MW-4, except for wells MW-1 and MW1B which are screened within the Memphis sand). MW-1A is a shallow well.

At seven locations, a shallow well and a deep well have been nested or installed adjacent to one another in order to investigate differences in characteristics with depth.

Deep monitoring wells at the Site (MW-1, MW-10, MW-12, and MW-14) established the potential presence of two aquifer systems at the site (Weston, 1986). Well nest MW-13 (shallow well) and MW-14 (deep well) indicated the presence of a perched water table in the fluvial deposits overlying the Jackson Formation separated from the major semi-confined aquifer system of the Memphis Sand unit. Shallow wells were installed to form nested pairs at locations MW-1, MW-10, and MW-12. The corresponding shallow wells are MW-1A,

MW-9, and MW-11 respectively. These wells were used to evaluate the presence and quality of shallow perched groundwater at the various locations at these sites.

Early monitoring of deep well MW-1 indicated the presence of TCE in the lower aquifer. In order to check the possibility that the installation of this pre-existing well had created an avenue for contaminant migration, a second deep well (MW-1B), screened at the same depth and placed within fifteen (15) feet was installed. MW-1B was installed following those techniques outlined for the deep wells as described in Section 3. The well installation was designed to minimize the potential for creating cross contamination between the two aquifer systems.

Since data from early groundwater analyses indicated the presence of TCE in the deep municipal wells and shallow MW-13, as well as deep well MW-1, well nest MW-5 and MW-6 were installed along the southwest side of the plant. This location was selected since it is near the location of the 1979 TCE release. The deep well (MW-6) would be situated between two potential source areas and the municipal wells. Shallow well (MW-5) would be near the 1979 spill area.

Water level from the deep wells indicated that the deep groundwater flow direction was toward the northwest. For this reason, a well nest consisting of shallow well MW-3 and deep well MW-4 was installed at the southeast corner of the plant property. The initial purpose of this well nest was to serve as an upgradient sampling location.

Shallow wells MW-19 and MW-21 were installed in the area of the closed sludge impoundment area which was located near the municipal well field, about 240 feet south of the east municipal well. These wells were installed to investigate shallow soil and groundwater conditions near the former surface impoundment site. No deep wells were established in this area due to the positive levels of contamination present in MW-19 and MW-21. Proposed shallow well MW-17 was not installed because no saturated or moist zone was identified above the aquitard. MW-19 was installed as a sump set in the clay for collection of groundwater. Recharge is minimal.

In order to assess the extent of groundwater contamination to the northeast from the area of shallow groundwater contamination found in wells MW-5, MW-13, MW-19, and MW-21, an additional shallow well MW-23 was installed near the northwest corner of the plant building. Well MW-15 was installed near the southwest corner of the plant area. This location is near contamination identified during the soil boring investigation. It is also potentially downgradient of the shallow perched aquifer area due west of the plant site. A deep well (MW-16) originally planned to be nested with MW-15 was relocated to the extreme southwest corner of the fenced plant area, due to the elevated levels of TCE found in MW-15.

Shallow wells MW-25 through MW-43 installed during Phase II were placed to delineate both onsite and potential offsite migration as outlined in the objectives set forth in Section 5.1. However, analytical results from the quarterly groundwater sampling events indicated TCE contamination in the shallow aquifer east and west of the Site.

Phase III field activities were implemented to further delineate offsite contamination. As previously described, a series of nine additional wells were installed, eight shallow and one deep. Phase III also incorporated the Piper Industry and Schilling Farms water wells (screened in the Memphis Sand). The wells are east and west of the site respectively. The monitoring well system established at the Carrier site as described above is the basis of the groundwater investigation conducted during the Remedial Investigation to assess the magnitude and extent of groundwater contamination at the site.

Gamma Logging

Upon completion of the Collierville Site investigation all monitoring wells were gamma logged. When used in conjunction with boring logs, downhole geophysics (gamma logging) aid in providing a more complete description of subsurface geology. All logging data are presented in Appendix F, and indicate varying levels of clay in the fluvial terrace deposits. There is also a distinct break in lithology which identifies the Jackson confining layer in the deep wells on site.

5.2.3 Geophysical Survey

During the Phase III field investigation a time domain electromagnetic (TDEM) survey was performed at the Collierville Site (June 1991, Progress Report). TDEM is a surface geophysical method which measures the electrical resistivity of the subsurface lithology. The survey conducted at the Site was limited to the open field west of the main plant due to surface interferences (i.e. fences, buildings, buried utilities). The objectives of the survey were to try to determine the elevation and relief of the top of the Jackson Clay layer and possibly determine the thickness and location of the "pinch-out" of the clay unit.

The results of the TDEM measurements were unsuccessful in determining a more definitive interpretation of the structure of the clay surface. The accuracy of the survey was within +/- 5 feet. However, a secondary interpretation of the survey noted that similar resistivities observed in the Jackson lithology "shallowed" to the south near Nonconnah Creek. Boring logs from monitoring wells (MW-35 and MW-49) also substantiate a transition into a sandy clay to the south at a more shallow interval.

5.3 Physical Geology/Hydrogeology

Section 2.0 on the regional geology states that the Carrier plant site occupies a tract of land adjacent to and including a portion of Nonconnah Creek. Results of the soil boring, gamma logging, and groundwater investigation indicate that the four major stratigraphic units previously described are also hydrostratigraphic units which characterize the local groundwater hydrology. The immediate stratigraphy of the study area consists of: (1) loess, a homogeneous, non stratified deposit consisting predominantly of silt with subordinate amounts of clay, (2) alluvium, detrital deposits, predominantly resulting from river action, including the sediments laid down in stream beds and flood plains, (3) Jackson-upper Claiborne, predominantly montmorillonite clays with lenticular beds of silt, fine grained sand, and lignite, and (4) the Memphis Sand, a thick body of sand with thin clay lenses at varying horizons and some lignite.

The Jackson Formation and Memphis Sand are both considered to be Eocene age deposits. A site specific hydrostratigraphic sequence is presented on Table 5-1 which was compiled

Table 5-1
Localized Hydrostratigraphic Sequence
for the Carrier Site

System	Series	Group	Stratigraphic Unit	Thickness	Hydrostratigraphic Significance
Quaternary	Pleistocene		Loess	16-30	Consisting of silty clay and clay silt with some fine sand. Principal surficial unit of the Gulf Coastal Plain. Tends to retard downward infiltration of water providing recharge to the fluvial deposits.
Quaternary	Pleistocene		Fluvial	8-37	AQUIFER unit composed of sand with some gravel and little silt or clay. Thickness varies because of erosional surfaces at top and base. Localized perched water of limited quantity.
Tertiary	Eocene	Claiborne	Jackson Formation	0-85	AQUITARD consisting of clay, silty clay, and sandy clay deposits. Serves as the upper confining unit of the Memphis sand restricting the downward recharge to the aquifer.
			Memphis Sand	500-890	AQUIFER predominantly sand and isolated lenses of clay. Principal aquifer providing water for municipal and industrial supplies.

Modified from: D.D. Graham and W.S. Parks, 1986, Potential for Leakage Among Principal Aquifers in the Memphis Area, Tennessee, U.S. Geological Survey, Water-Resources Investigations Report 85-4295, 46p.

from onsite boring logs, gamma logs, and regional published information.

A deposit of loess or wind deposited silt, ranging in thickness up to 30 feet, is the surficial material covering most of the site area. The loess deposit is weathered to varying degrees into clayey silt and silty clay material. This relatively fine particle-sized material is less able to transmit water through the small intergranular pores, and therefore the unit has a significantly lower hydraulic conductivity than the coarser sand and gravel units. Having a low hydraulic conductivity causes the strata to retard downward infiltration of water to the underlying formations. In the site area, the loess deposit is unsaturated and water movement through this vadose zone consists of infiltration and percolation of precipitation. The channel of Nonconnah Creek appears to have eroded through the loess deposits south of the site and into the underlying fluvial deposits.

Surface elevation of Nonconnah Creek is about 324 feet, (msl) which is approximately the base of the loess deposits based on extrapolation of the geologic cross-section (Plate 2). The creek channel then appears to be incised into the lower fluvial deposits.

Fluvial deposits at the site consist of sand with varying amounts of silt and gravel. In the site area, these deposits vary in thickness from less than 10 feet to more than 35 feet. These are older alluvial deposits from either present day streams (such as Nonconnah Creek) or paleo drainage systems. Groundwater has been encountered at the site in the lower portions of the fluvial deposits in localized areas. This groundwater is perched above the contact of the coarser grained fluvial deposits and the underlying clay of the Jackson Formation. Plate 2 shows the presence of this perched groundwater zone.

In some areas, only a very small quantity of groundwater was encountered at the contact and the shallow wells transmitted insufficient water for sampling (MW-1A, MW-9, MW-11, MW-15, MW-25, MW-33, MW-41, MW-43, MW-47, MW-49, MW-51, MW-53, and MW-55). Other areas had several feet of perched water. Because the stratum is capable of transmitting groundwater and in fact contains groundwater, it is considered to be the uppermost aquifer unit at the site. The fluvial deposits, like the loess deposits, appear to be continuous throughout the area of investigation, although the thickness is variable.

The Jackson Formation is the confining bed between the perched upper aquifer and the semi-confined Memphis Sand which is considered the lower aquifer at the site. This aquitard is composed predominantly of clay and silt with some sand. It ranges in thickness from 85 feet at the northwest corner of the site to being absent near Nonconnah Creek as illustrated in the geologic cross-section of the study area. This unit is composed of lenses and interfingered layers of relatively fine grained deposits. Permeability tests described in Section 5.2.1 indicate that the formation contains clay rich zones with low hydraulic conductivity. Therefore, the unit may restrict the vertical movement of water from the shallow fluvial deposits to the Memphis Sand in areas where it is present with a competent thickness. (An aquifer pump test conducted at the site and described later indicates that the unit's ability to restrict vertical movement may exhibit localized deterioration. The TDEM survey also substantiated a gradual change in lithology in the southern portion of the Site.)

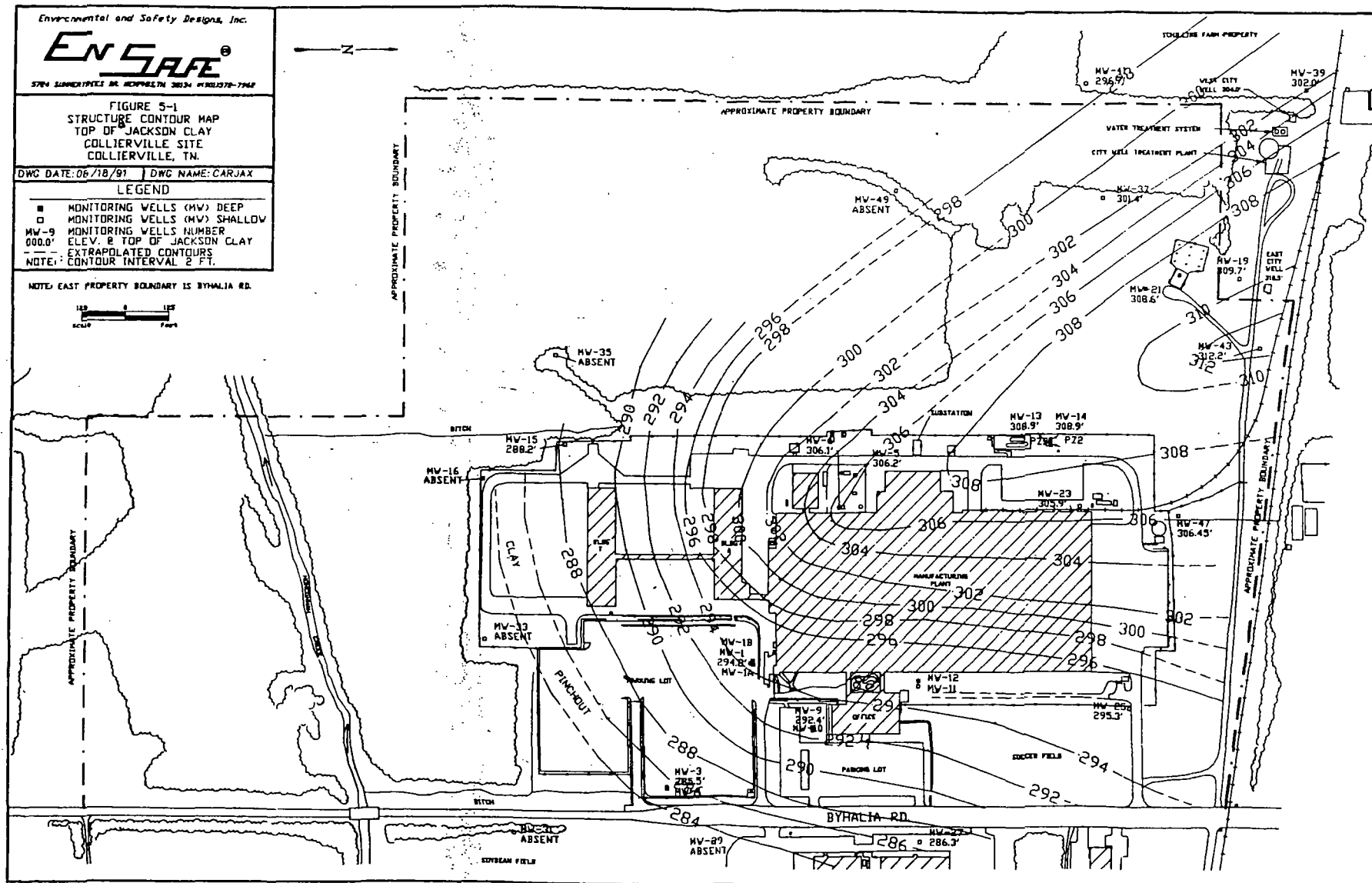
A structure contour map was generated from borings completed to the top of the Jackson Formation during the field investigation (Figure 5-1). The structure map reveals

5784 SANDWICHES BE MEMPHIS 38124 61801372-7264

DWG DATE: 06/18/91 DWG NAME: CARJAX

■ MONITORING WELLS (MW) DEEP
 □ MONITORING WELLS (MW) SHALLOW
 MW-9 MONITORING WELLS NUMBER
 000.0' ELEV. @ TOP OF JACKSON CLAY
 — — — EXTRAPOLATED CONTOURS
 NOTE: CONTOUR INTERVAL 2 FT.

NOTE: EAST PROPERTY BOUNDARY IS BYHALIA RD.



a topographic high which underlies the northwest corner of the property in the vicinity of the former sludge impoundment area. The formation appears to slope almost radially with a prominent downgradient direction toward the east-southeast and to the west. No borings were completed to the top of the confining layer in the area south of the former sludge area; therefore, structural changes which may or may not exist in this area are uncertain.

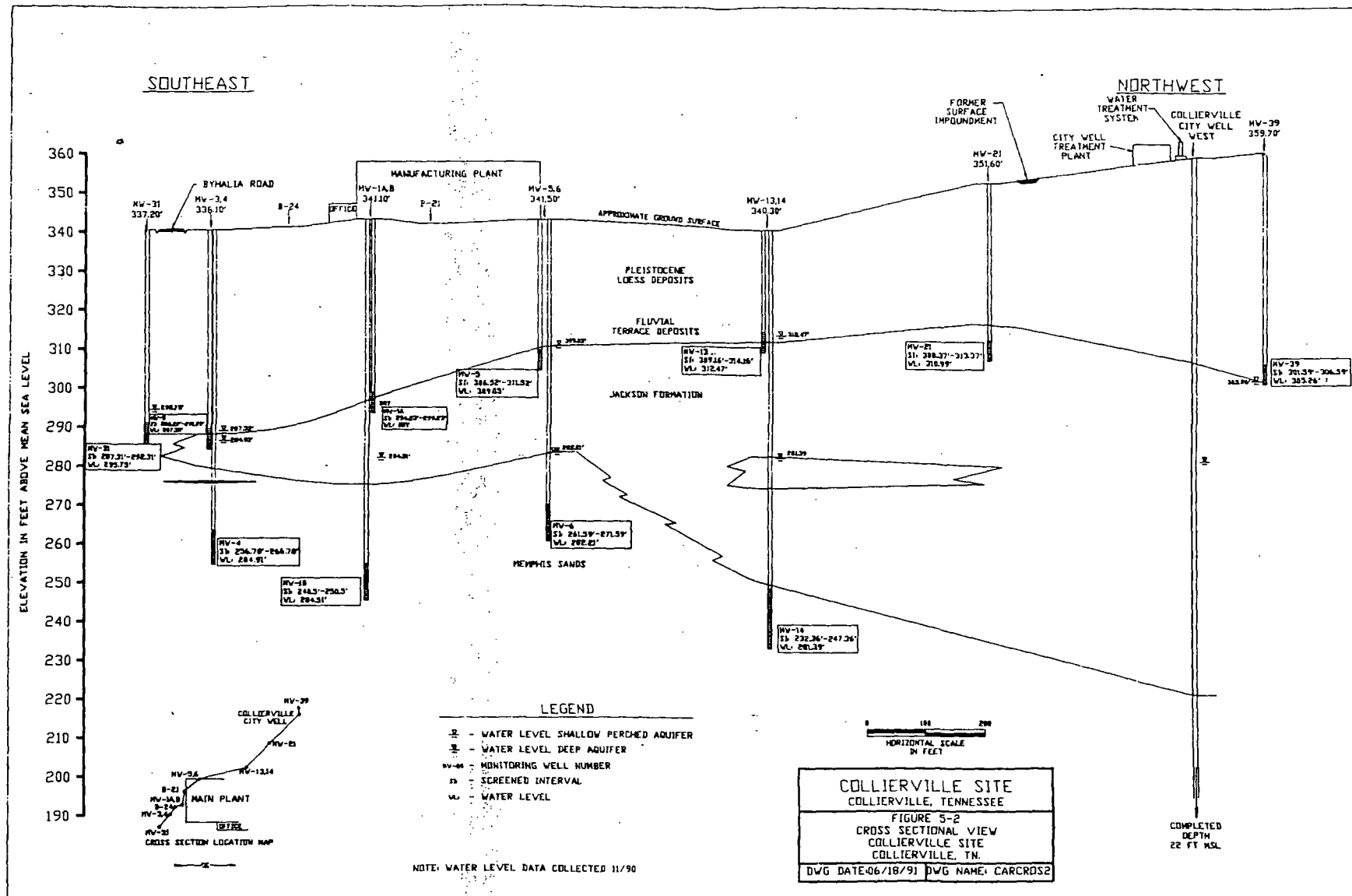
The Memphis Sand aquifer is a thick sequence of relatively clean sand with varying amounts of gravel and occasional clay lenses. It is confined beneath the Jackson Formation in most of the site area where it exists under artesian conditions. However, where the Jackson Formation pinches out, the Memphis Sand unit has no confining bed and becomes an unconfined aquifer. The two water bearing strata can be seen to merge towards the southeastern limit of the site investigation area from the cross sections in Figure 5-2 and 5-2.1.

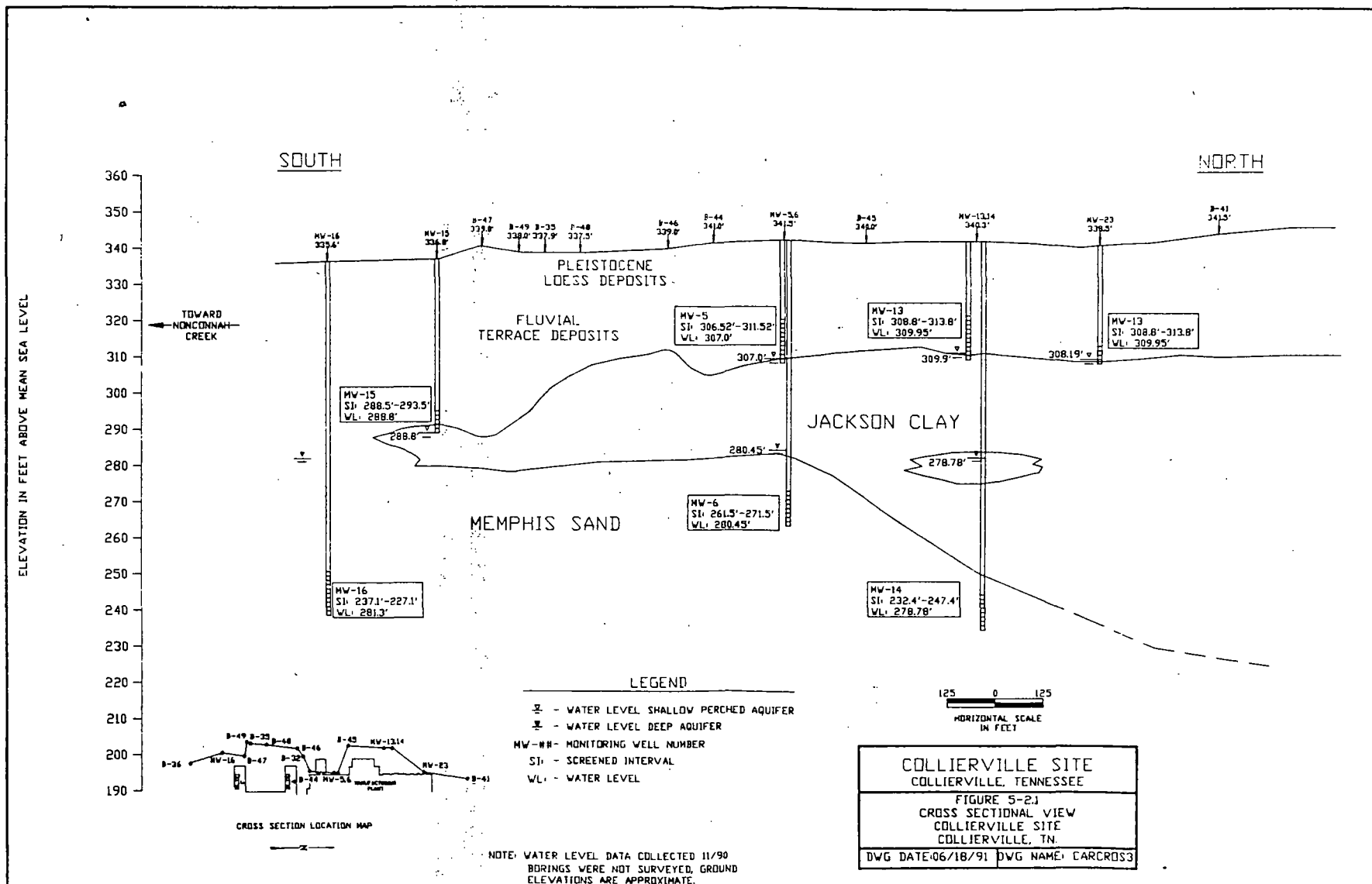
5.4 Aquifer Characteristics

Section 5.3 describes the potential for two distinct aquifer systems at the Collierville Site. These aquifers are the shallow water table aquifer which appears to be stratigraphically associated with the fluvial terrace deposits, and the Memphis Sand aquifer.

5.4.1 Upper Aquifer

Groundwater which is perched above the Jackson Formation in the sandy fluvial deposits beneath the site is referred to as the upper aquifer. This perched zone is limited in





saturated thickness to only a few feet or less. Recharge to the perched groundwater zone in this area is from infiltration of precipitation through the overlying loess and unsaturated fluvial deposits and is variable. Water level measurements collected from the monitoring wells which are screened at the interface of the Jackson Formation and the overlying fluvial deposits were used to construct the water table contour map shown on Figure 5-3. The map indicates an area of water level elevation greater than 310 feet (msl) in most of the area west and northwest of the plant building. Water levels then decrease in elevation toward the southeast and northeast in a radial pattern from the area of higher hydraulic head. Hydraulic gradients range from 0.01 ft./ft. between wells MW-13 and MW-23 where flow is toward the northeast, to 0.05 ft./ft. at MW-5 based on the contour map which shows groundwater gradients to the southeast. The hydraulic gradient between wells MW-21 and MW-37 was calculated to be 0.02 ft./ft. to the south-southwest.

Although no aquifer tests have been performed in the upper aquifer to date, groundwater velocities were estimated for this zone based on the calculated hydraulic gradients and an assumed permeability value.

Groundwater velocity is calculated using the following equation.

$$(1) \quad V = Ki/n$$

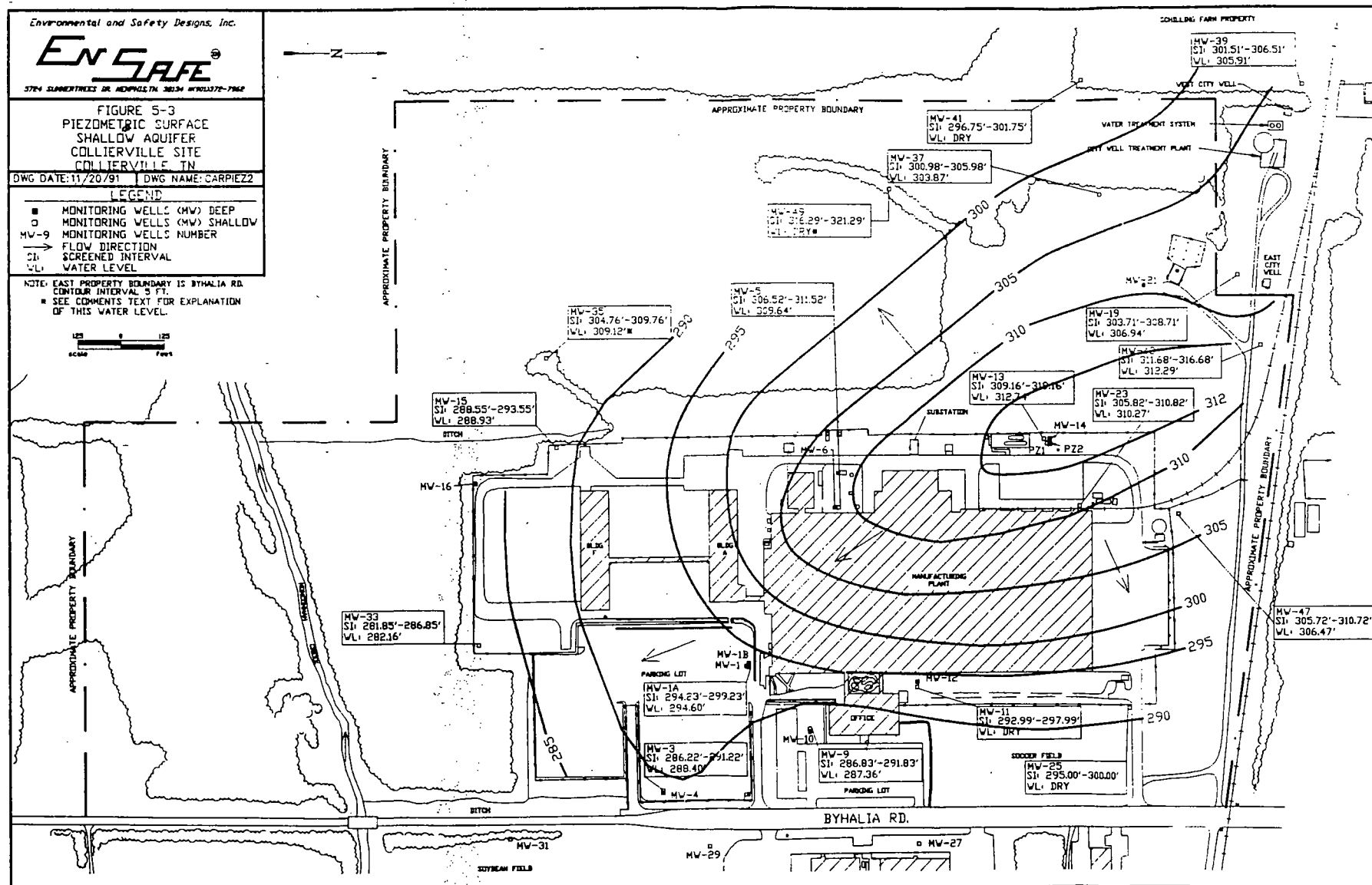
Where:

V = Horizontal velocity

K = Hydraulic conductivity

V = Hydraulic gradient

n = Effective porosity



Using the equation above with an assumed effective porosity of 25 % (USGS, 1989) the groundwater velocity for flow toward the northeast in the upper aquifer is estimated to be about 5 feet per day. Groundwater velocity to the southeast in the area of MW-5 is estimated to be 27 feet per day. Groundwater flow to the southwest is estimated to be 11 feet per day. These calculated groundwater velocities are relatively fast. However, field observations over a four year period have led us to postulate that the groundwater encountered in the upper aquifer may be perched and only present in localized depressions in the surface of the Jackson Formation with very little lateral movement of water actually occurring except during recharge periods.

5.4.2 Lower Aquifer

The major source of groundwater in the Collierville area is the Memphis sand aquifer. Groundwater in this aquifer is allegedly confined under artesian conditions beneath the Jackson Formation clay. However, as illustrated on Plate 2, where the Jackson Formation is absent, unconfined water table conditions exist. This occurs to the south and southeast of the site along Nonconnah Creek where alluvial deposits from the creek, fluvial terrace deposits, and the Memphis sand unit all become hydraulically interconnected.

In order to assess the aquifer characteristics of the Memphis sand, a constant rate aquifer pumping test was performed. Since the municipal well field is situated within the area of investigation, it was decided to use the municipal wells in the test. The pumping was performed on the west municipal well. The east municipal well and monitoring well MW-14 were used as the primary observation wells. Water levels in all onsite wells, were periodically measured during the test. The complete report describing the aquifer test and results is presented in Appendix K, and is summarized below.

In preparation for the aquifer tests, the pumps in the municipal wells were shut down so that the water levels could return to natural conditions. Pressure transducers connected to data logging units were installed in the two municipal wells and MW-14. Antecedent water level measurements were recorded hourly for a period of one week. The aquifer pumping test was then initiated and continued for approximately 48 hours.

Static water level measurements from each of the monitoring wells in the lower aquifer were collected prior to pumping and were used to construct a potentiometric contour map for the lower aquifer (Figure 5-4). The map indicates that groundwater movement in the Memphis Sand at the site is toward the northwest. Therefore, the municipal well field is directly downgradient of the Carrier plant. Water level measurements collected from the same wells during the aquifer test while a pumping stress was placed on the aquifer system indicate that pumping had no obvious effect on groundwater flow direction or gradients in the plant area. The only noted effect was a nearly uniform decrease in water levels of about 0.5 foot. This indicates that the entire site is within the cone of depression created in the Memphis Sand unit by the pumping of the municipal wells.

Antecedent water level measurements collected prior to the aquifer tests were used to evaluate daily trends during non-pumping periods. These measurements have been graphed to illustrate the water level trends concurrent with the aquifer tests (Figures 5-5 and 5-6). Each of the three graphs show the same general trends. There appears to be a slight but

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FIGURE 5-4
PIEZOMETRIC SURFACE
DEEP AQUIFER
COLLIERVILLE SITE
COLLIERVILLE, TN.

DWG DATE: 10/04/90 DWG NAME: CARPIEZ1

LEGEND

- MONITORING WELLS (MW) DEEP
- MONITORING WELLS (MW) SHALLOW
- MW-9 MONITORING WELLS NUMBER
- FLOW DIRECTION
- NOTE: EAST PROPERTY BOUNDARY IS STHALIA RD.
CONTOUR INTERVAL 0.5 FT

1" = 50' 0"

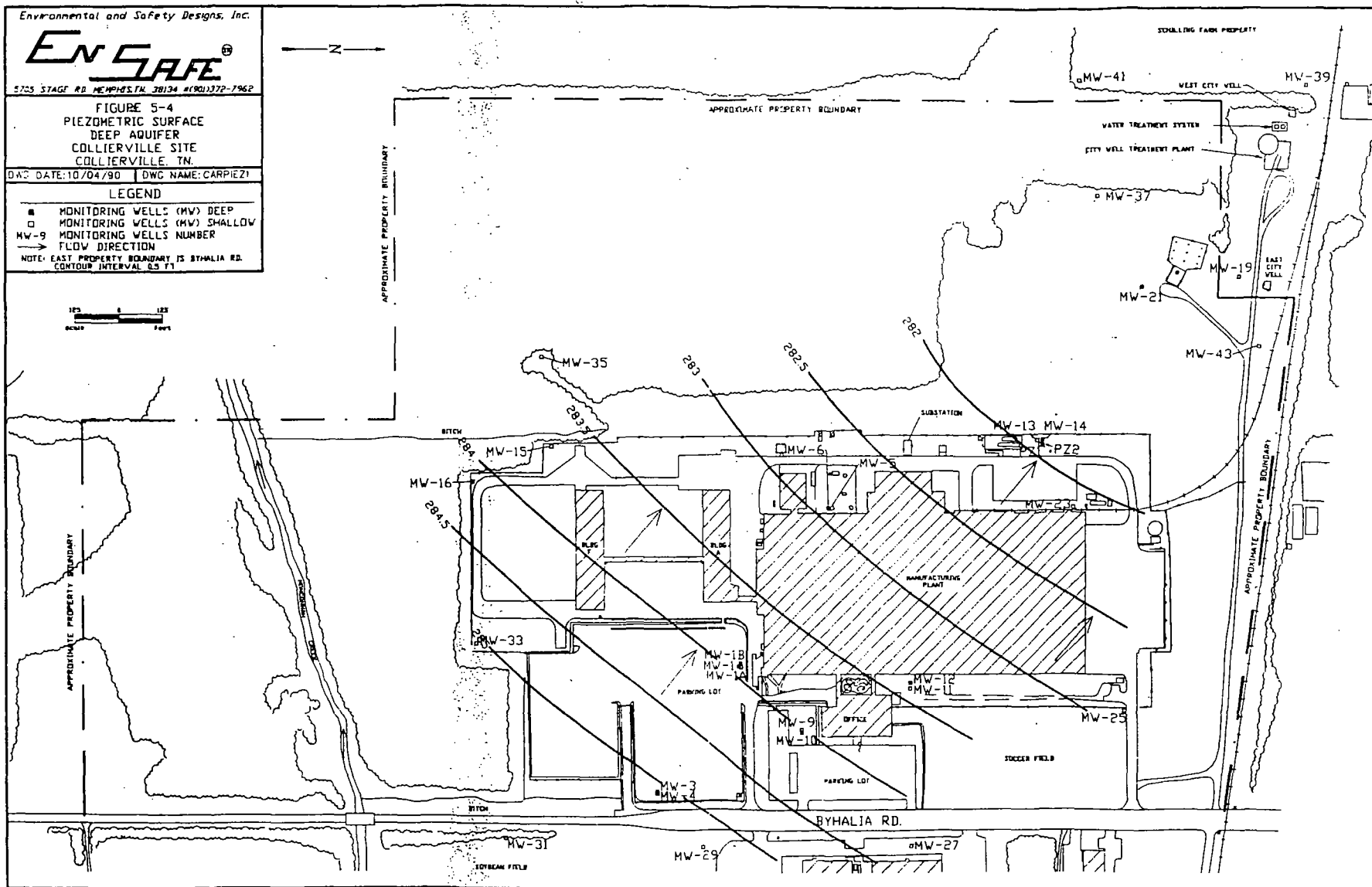
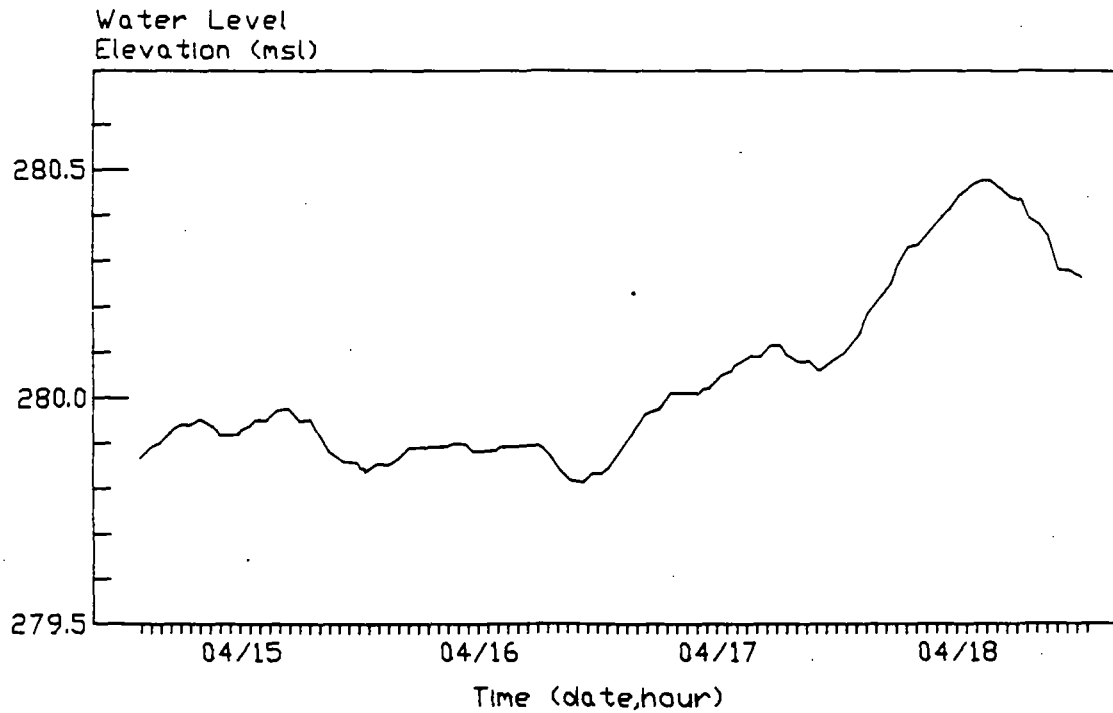


FIGURE 5-5
Antecedent Water Level
City Well West
04/14/88 - 04/18/88



Local Shelby County Precipitation
for April 1988. Measured at the
Memphis International Airport.

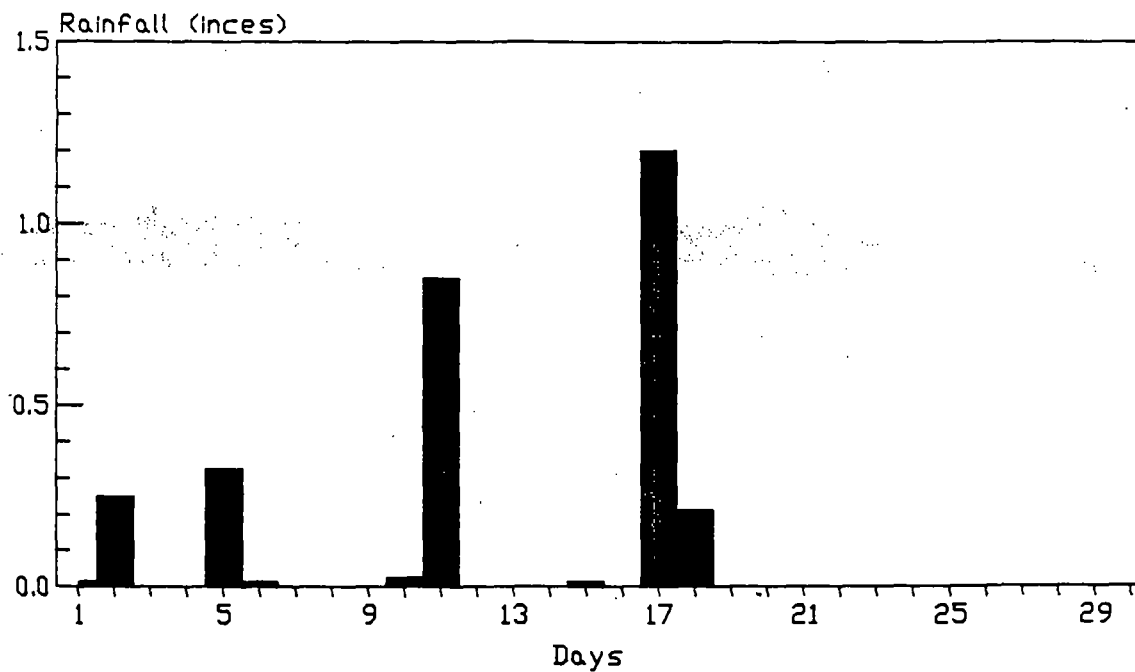
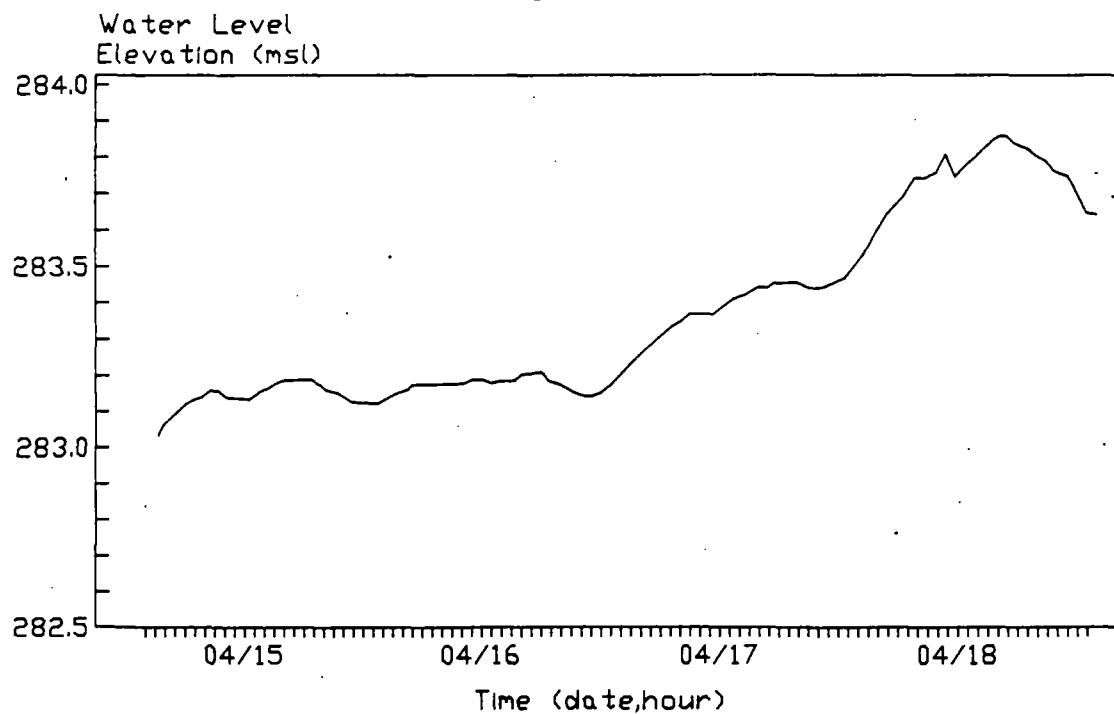
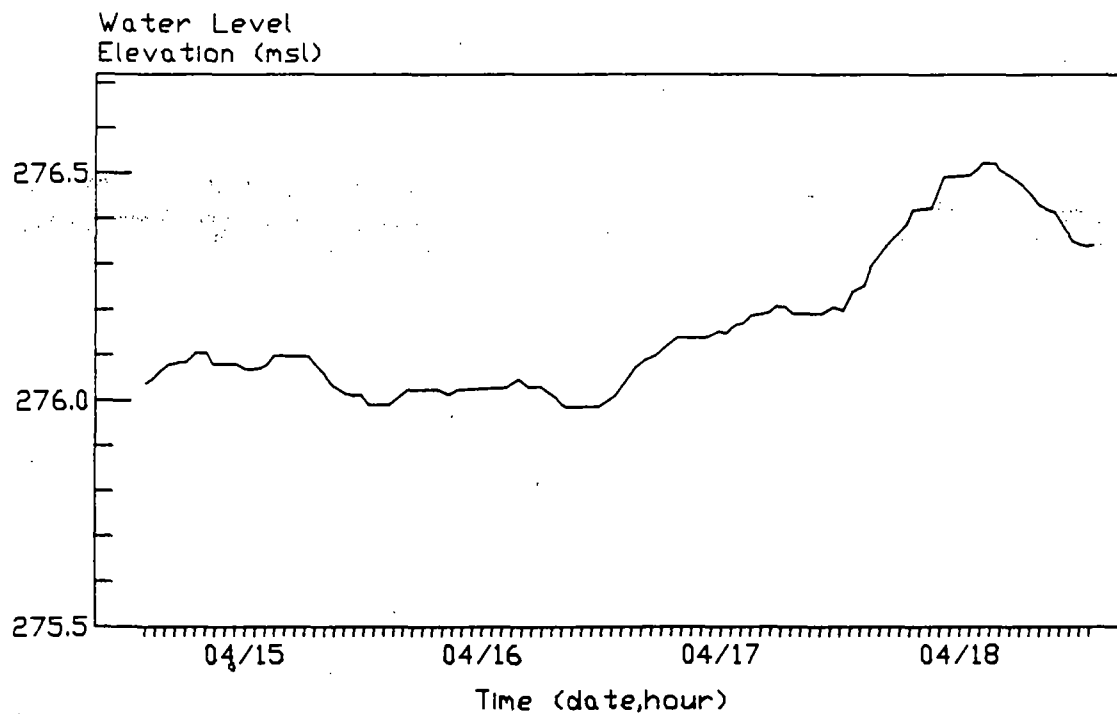


FIGURE 5-6
Antecedent Water Level
Observation Water Well #14
04/14/88 - 04/18/88



Antecedent Water Level
City Well East
04/14/88 - 04/18/88



distinct semi-diurnal fluctuation which can be observed on the graphs. This phenomenon could be attributed to earth tides which are reflected in the potentiometric water levels of some confined aquifers. In conversation with Mr. William Parks of the U.S.G.S. in Memphis, Mr. Parks reported that he had observed similar trends in water levels of other wells in Shelby County which penetrate into the Memphis Sand (Personal Communication). The earth tidal effects result from the attraction exerted on the earth by the moon and to a lesser extent, the sun. These earth tidal effects documented in other wells appear as two daily cycles of small magnitude fluctuations which occur about 50 minutes later each day.

Antecedent water levels were also measured about the time of the new moon lunar phase. During times of new and full moons, the tide-producing forces of the sun and the moon act in the same direction and the effect on water levels can be more pronounced. Another trend observed in the three antecedent water level graphs is a distinct rise in the water level which begins early April 17 and peaks on the afternoon of April 18. Water levels then decline. The increase in water level was about 0.5 feet or more in each well. This increase could be related to a change in barometric pressure, but is more likely to be a response to a precipitation event. Two major precipitation events occurred in April prior to the reported increase in water levels. On April 11, about 0.8 inches of rainfall and 1.18 inches of rain on April 17, 1988, occurred in the vicinity of the site. If the rise in water levels seen on data from April 17 and 18, 1988, is related to the rainfall of April 17 and 18, 1988 then recharge to the lower aquifer could be relatively rapid.

Additional recharge to the lower aquifer is derived from leakage through the Jackson Formation to the upper aquifer. Analysis of the aquifer pumping test data (Appendix K) indicates that between 1,300 and 27,000 gallons per day per acre could be leaking through the confining aquitard into the lower aquifer.

Groundwater levels had been contoured for the lower aquifer on the potentiometric contour map on Figure 5-4. From this contour map, the hydraulic gradient was measured to be 0.0017 ft/ft. Aquifer characteristics derived from the aquifer pumping test were as follows:

Transmissivity (gpd/ft)	Storage Coefficient (dimensionless)	Vertical Permeability of the Aquitard (gpd/ft ²)	Horizontal Permeability of The Memphis Sand (gpd/ft ²)
242,500	0.001-0.0001	0.03-0.62	1,212.5

Groundwater velocity in the lower aquifer can be calculated using equation (1) and the parameters derived from the aquifer test. The effective porosity is estimated to be 25 % for the aquifer. The groundwater velocity is calculated to be about 8 feet per day during non-pumping conditions. Flow velocities are not expected to differ from this value during pumping of the municipal wells except in the immediate vicinity of the wells. The cone of depression which developed from pumping the aquifer at approximately 470 gallons per minute was rather broad but not very deep, which is typical of formations with high transmissivity values.

Recharge to the lower aquifer is predominantly through infiltration of precipitation and surface water in areas where the aquifer is unconfined. Nonconnah Creek has a water level elevation of approximately 324 feet (msl).

Water levels collected from monitoring wells in the upper and lower aquifers at the southern and southeastern portion of the Site are as follows:

<u>Well</u>	<u>Elevation (msl)</u>
MW-3	288
MW-4	285
MW-15	289
MW-16	285
MW-33	286
MW-35	308
MW-59	286
MW-61	286

Since the Creek level is as much as 35 feet higher in elevation than water levels in the aquifers, it is an influent stream which probably supplies significant recharge to the aquifer system. Furthermore, Nonconnah Creek may serve as a groundwater divide which further inhibits the migration of contaminants.

5.4.3 Confining Layer

Vertical hydraulic conductivity values have been calculated for the site from data generated during the aquifer pumping test. Permeability tests performed on clay samples collected from the Jackson Formation confining strata indicate that the permeability of the clay is in the range of 1×10^{-7} to 1×10^{-8} cm/sec. However, vertical permeability values derived from the Walton Leaky Artesian Aquifer pumping test analysis were calculated to be 2.9×10^{-5} and 1.7×10^{-6} cm/sec for the two observation wells. These values translate to 1,300 to 27,000 gallons per day per acre. Vertical hydraulic gradients calculated for several well nests both before and during the aquifer pumping test are presented in Appendix K. The value used for calculating the vertical leakage through the confining aquitard is 1.0 ft/ft. Using the parameter values for vertical hydraulic conductivity and hydraulic gradient and

an estimated value of 10% for the effective porosity of the confining clay in equation (1) for calculating flow velocity, the vertical flow velocity through the confining Jackson Formation is on the order of 0.04 to 0.83 feet per day.

5.5 Nature and Extent of Contamination

Results of the Collierville Site Investigation show varying levels of TCE contamination on the property. Results from soil analyses suggest that the spill areas and the clarifier sludge impoundment area may each be a contributing factor in the overall contamination of the site.

5.5.1 Volatile Organics in Soil

Results of trichloroethylene screening tests on soil samples collected from the eighty seven (87) borings completed during the field activities are included in Appendix I. Figure 5-7 is an isocon map which graphically displays trichloroethylene soil testing results in the vicinity of the plant.

Soil samples collected within the parameters of the spill areas indicate a wide range of levels of contamination. Samples from this area ranged in levels from <.5 ppb up to 1,550,000 ppb. The greatest concentrations (B-4, B-9, B-21, and B-38) were from those areas more directly associated with the 1979 degreaser spill. The vertical extent of TCE contamination is variable throughout the site. Migration of contaminants downward is a direct result of soil permeability in the vadose zone. Soil screening methods indicate that

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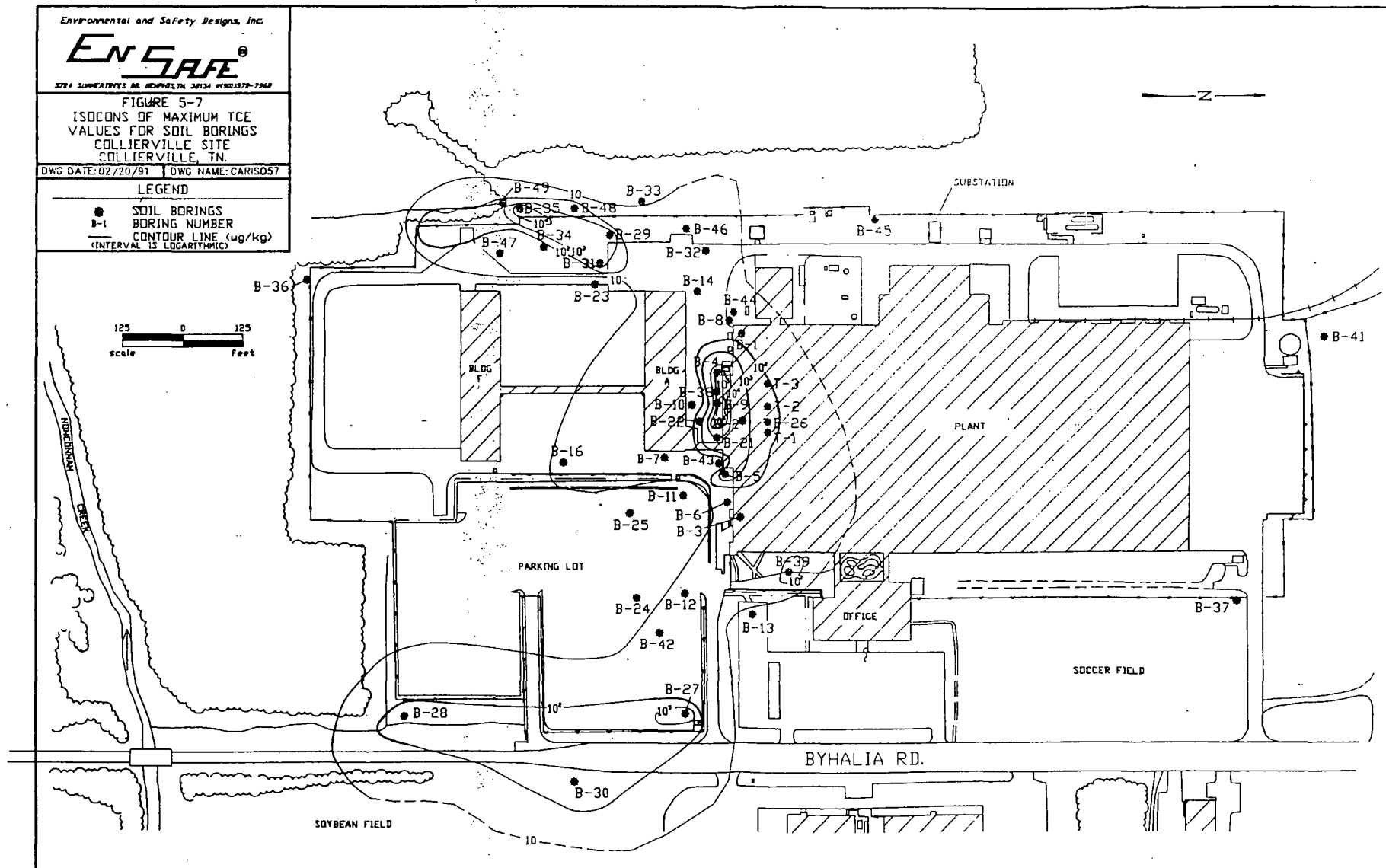
STATE SUBMITTALS BY: MEMPHIS, TN 38134 HUNTSVILLE, TN 38801

FIGURE 5-7
ISOCONS OF MAXIMUM TCE
VALUES FOR SOIL BORINGS
COLLIERVILLE SITE
COLLIERVILLE, TN.

DWG DATE: 02/20/91 DWG NAME: CARIS057

LEGEND

● SOIL BORINGS
B-1 BORING NUMBER
— CONTOUR LINE (ug/kg)
(INTERVAL IS LOGARITHMIC)



many of the sample's concentration levels decrease with depth. However, there are samples which indicate an increase in concentrations as the zone of saturation in the shallow aquifer is approached.

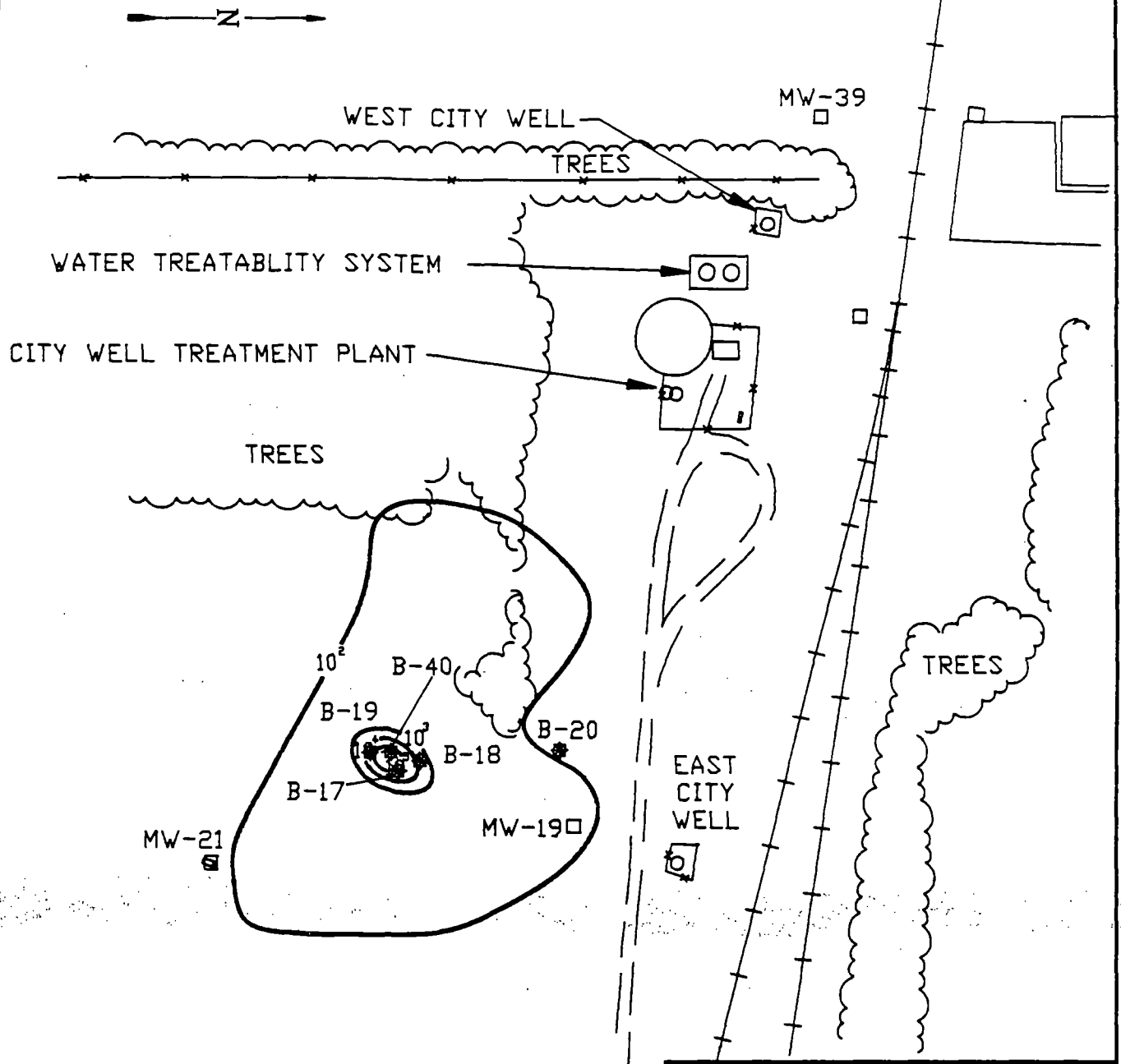
Samples collected from the sludge area (borings B-17, B-18, B-19, and B-40) all confirm the presence of TCE in the subsurface soils. Figure 5-8 is an isocon map which displays trichloroethylene soil testing results from that area.

Anomalous values for TCE values were also identified in soil borings in outlying areas southeast of the plant (B-27, B-28, and B-30). These values are thought to be associated with exfiltration of contaminants from the sewer system near B-27 and losses to the ditch via stormwater near B-28. Levels of TCE in B-30 were detected at depth only, which is further supported by the lack of TCE in shallow samples collected from MW-31, MW-33, MW-59, and MW-61.

Boring 29 also showed high levels of contamination during the Investigation. The source of contamination in this area is unknown but potentially could have been from washdown from the 1979 spill incident. This area is included with the isocons on Figure 5-7. Tables 5-2 and 5-3 summarize TCE concentrations from soil borings completed during Phase II and Phase III of the investigation.

To delineate the dimensions of the TCE-affected soils in the former sludge area, a limited soil gas survey utilizing organic vapor readings in shallow borings was performed. This survey is described below.

SCHILLING FARM PROPERTY



LEGEND

- FENCE
- GRAVEL ROAD
- + + + RAILROAD
- CONTOUR LINE (ug/kg)
(INTERVAL IS LOGARITHMIC)

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FIGURE 5-8
ISOCONS OF MAXIMUM TCE
VALUES FOR SOIL BORINGS
COLLIERVILLE SITE
COLLIERVILLE, TN.

DWG DATE: 02/20/91 DWG NAME: CARISO58

**TABLE 5-2
SUMMARY OF HIGHEST CONCENTRATIONS FROM
MONITORING WELLS UTILIZING FIELD SCREENING
METHODOLOGIES**

MONITORING WELL	TCE VALUE $\mu\text{g/kg}$	DEPTH INTERVAL FT.
MW3	10	20
MW5	20	10
MW9	NONE DETECTED	ALL DEPTHS
MW11	NONE DETECTED	ALL DEPTHS
MW15	160	50
MW16	NONE DETECTED	ALL DEPTHS
MW17	450	52.5
MW19	430	50
MW21	110	42.5
MW23	NONE DETECTED	ALL DEPTHS
MW27	NONE DETECTED	ALL DEPTHS
MW29	NONE DETECTED	ALL DEPTHS
MW31	NONE DETECTED	ALL DEPTHS
MW33	NONE DETECTED	ALL DEPTHS
MW35	NONE DETECTED	ALL DEPTHS
MW37	NONE DETECTED	ALL DEPTHS
MW39	70	10
MW41	310	55
MW43	NONE DETECTED	ALL DEPTHS
MW45	NONE DETECTED	ALL DEPTHS
MW47	NONE DETECTED	ALL DEPTHS
MW51	NONE DETECTED	ALL DEPTHS
MW53	NONE DETECTED	ALL DEPTHS
MW55	NONE DETECTED	ALL DEPTHS
MW57	NONE DETECTED	ALL DEPTHS
MW59	NONE DETECTED	ALL DEPTHS
MW61	NONE DETECTED	ALL DEPTHS

**TABLE 5-3
SUMMARY OF HIGHEST TCE CONCENTRATIONS FROM
SOIL BORINGS UTILIZING FIELD SCREENING
METHODOLOGIES**

BORING	TCE VALUE $\mu\text{g/kg}$	DEPTH INTERVAL FT.
B1	20	20
B2	2600	20
B3	40	10
B4	250,000	1.5
B5	1850	20
B6	20	10
B7	20	5
B8	50	10
B9	1,550,000	10
B10	10	20
B11	NONE DETECTED	ALL DEPTHS
B12	40	20
B13	NONE DETECTED	ALL DEPTHS
B14	10	20
B15	NOT ANALYZED	ALL DEPTHS
B16	30	10
B17	168,000	15
B18	16,000	5
B19	920	15
B20	NONE DETECTED	ALL DEPTHS
B21	20,000	5
B22	110	1.5
B23	NONE DETECTED	ALL DEPTHS
B24	NONE DETECTED	ALL DEPTHS
B25	NONE DETECTED	ALL DEPTHS
B26	440	20
B27	3,000	55

TABLE 5-3
SUMMARY OF HIGHEST TCE CONCENTRATIONS FROM
SOIL BORINGS UTILIZING FIELD SCREENING
METHODOLOGIES

BORING	TCE VALUE $\mu\text{g/kg}$	DEPTH INTERVAL FT.
B28	220	20
B29	5,800	1.5
B30	230	70
B31	5,800	0
B32	40	10
B33	NONE DETECTED	ALL DEPTHS
B34	40	20
B35	22,000	20
B36	NONE DETECTED	ALL DEPTHS
B37	NONE DETECTED	ALL DEPTHS
B38	299,000	1
B39	122	10
B40	1,890	5
B41	NONE DETECTED	ALL DEPTHS
B42	10	55
B43	30	10
B44	20	5
B45	NONE DETECTED	ALL DEPTHS
B46	90	15
B47	10	40
B48	440	15
B49	170	45
B51	NONE DETECTED	ALL DEPTHS
B53	NONE DETECTED	ALL DEPTHS

Soil-Gas Survey

To determine if any sludge or contaminated soil remained following the sludge impoundment closure and removal of a layer of subsoil beneath it in 1980 additional soil samples were collected. The results of this aspect of the investigation indicate high levels of trichloroethylene in the soil (Table 5-2, borings B-17 through B-19, and B40). In order to establish the corresponding monitoring wells with the old sludge area, a soil-gas survey was implemented to determine the approximate horizontal extent of contamination.

Sampling results (Appendix I) show that the highest level of TCE contamination in this area was boring (B-17). B-17 was established as a grid centerpoint and a corresponding north-south and an east-west line passed through this point. Grid points were established at 20 foot intervals and extended outward from the centerpoint for a distance of 100 feet. In addition, a boring was placed at the corner of each axis, at 45 degrees from B-17. At each point along the axis a borehole was installed to a depth of 15 feet.

Immediately upon drilling each borehole, an organic vapor detector (hNu) was used to monitor organic vapors coming from the annulus of the borehole. These readings were recorded, and if a positive value were obtained then drilling proceeded as scheduled. If a negative deflection or "O" value was obtained, then drilling concluded along that coordinate and began on an alternating axis.

After drilling each borehole and obtaining an immediate organic vapor reading, the opening to the borehole was covered with clear plastic and anchored in place. After an elapsed period of not less than 24 hours, an additional reading was taken at each boring location. A small incision was made in the plastic covering the borehole opening, and

accumulated vapors were again monitored using an organic vapor detector. Results from these readings were instrumental in determining the location of the lagoon area monitoring wells.

The results from the soil gas survey suggested that there were significant concentrations of TCE vapors in the soil in the former sludge placement area, and allowed the location of this closed impoundment to be further defined.

5.5.2 Volatile Organics in Groundwater

Upon completion of the Collierville site investigation a total of thirty seven (37) groundwater wells were present at the site. Table 3-3 is a complete summary of all well construction data from the Site. Samples were collected from the deep wells by dedicated pumps and the use of a Teflon bailer in the shallow wells. Sampling of the new wells followed standard operating procedures identified in the EPA approved Sampling Plan and previously described in Section 3. Historical laboratory results beginning in September of 1987 through the present are included for all monitoring wells in Appendix D. Laboratory analyses completed during the RI are included in Appendices C and H.

During each sampling period, a groundwater level was measured and recorded for each well. These measurements were converted to elevations relative to a set datum (mean sea level, msl). These measurements were later used to determine potentiometric surface maps included previously.

Concentrations of chlorinated hydrocarbons consisting primarily of trichloroethylene and 1,2-dichloroethene have been reported in samples collected from most of the monitoring wells screened in the upper aquifer. Total chlorinated hydrocarbon (TCH) concentrations in these wells range from 70 micrograms per liter at well MW-23 to 19,900 micrograms per liter at well MW-19 during the last RI sampling period in February, 1991. All wells with elevated levels of TCE and its degradation products are outlined in Table 5-4.

There are three distinct areas where high levels of contaminants were found in the uppermost aquifer during the investigation. Well nest MW-3 and MW-4 were initially installed for use as upgradient wells. Their location was based on the data from previously installed wells which indicated a northwest flow direction in the lower aquifer. During the investigation, it was found that MW-3 was actually downgradient of the areas where TCE spills had occurred. Flow directions in the two aquifers were found to be virtually opposite one another.

Well MW-31 southeast of MW-3 and across Byhalia Rd. indicates the presence of TCE and its degradation products in groundwater. This well is southeast of where the Jackson clay pinches out at the Site. Even higher contaminant levels were recorded in samples from wells MW-19 and MW-21. These wells are located in the vicinity of the former surface impoundment. In addition, wells MW-37 and MW-39, southwest and west of the impoundment area have been impacted by chlorinated hydrocarbons.

TABLE 5-4

Wells	Trichloroethylene µg/l						Dichloroethylene µg/l					
	Sampling Quarter						Sampling Quarter					
	1	2	3	4	5	6	1	2	3	4	5	6
MW1	680	480	600	570	840		62	50	77	88	130	
MW1B	1100	1000	820	710	950		250	170	250	270	300	
MW3	4400	9000	5100	5900	250		5300	4400	3900	BDL	190	
MW4	85	9	20	23			9	15	5	BDL		
MW5	42000	4900	6000	5800	8700		48000	2400	610	640	1100	
MW6	2J	3J	3J	BDL	BDL		BDL	BDL	BDL	BDL	BDL	
MW10	3J	1J	BDL	BDL	BDL		BDL	BDL	BDL	BDL	BDL	
MW13	140	160	120	110	127		BDL	2J	3J	3J	BDL	
MW14	BDL	BDL	BDL	2J	BDL					BDL		
MW15	NS	NS	NS	NS	NS		NS	NS	NS	NS	NS	
MW19	NS	14000	24000	7300	7700		NS	5400	2100	12000E	12000	
MW21	18000	680E	5400	NRS	NRS		2900	380E	410	NRS	NRS	
MW23	63	79	89	120	59		7	1J	4J	11	11	
MW31	NI	NI	170	980	1100	250E	NI	NI	36	230	260	52
MW35	NI	NI	58J				NI	NI	BDL			
MW37	NI	NI	360	840	680E	1200	NI	NI	BDL	14J	36	160
MW39	NI	NI	3500	3400	4400		NI	NI	BDL	BDL	BDL	

NOTES:

- BDL - Below Detection Limit
- NS - Not Sampled (due to insufficient amount of groundwater in well)
- * - MW-15 Sampled in previous investigations
- NI - Not Installed (at time of sample event)

TABLE 5-4

Wells	Trichloroethylene µg/l							Dichloroethylene µg/l						
	Sampling Quarter							Sampling Quarter						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7
MW51	NI	NI	NI	NI	NI	NS	NS	NI	NI	NI	NI	NI	NS	NS
MW53	NI	NI	NI	NI	NI	NS	7	NI	NI	NI	NI	NI	NS	BDL
MW55	NI	NI	NI	NI	NI	NS	NS	NI	NI	NI	NI	NI	NS	NS
MW57	NI	NI	NI	NI	NI	BDL	22	NI	NI	NI	NI	NI	BDL	BDL
MW58	NI	NI	NI	NI	NI	NI	BDL	NI	NI	NI	NI	NI	NI	BDL
MW59	NI	NI	NI	NI	NI	BDL	BDL	NI	NI	NI	NI	NI	BDL	3J
MW61	NI	NI	NI	NI	NI	BDL	BDL	NI	NI	NI	NI	NI	BDL	3J

NOTES:

- BDL - Below Detection Limit
 NS - Not Sampled (due to insufficient amount of groundwater in well)
 * - MW-15 Sampled in previous investigations
 NI - Not Installed (at time of sample event)

The highest recorded concentrations of TCE were found in a sample taken from MW-15 during January 1988 when a concentration of 150,180 micrograms per liter was detected. However, this groundwater sample is indicative of stagnant water conditions. Due to the virtually non-existent recharge of the shallow aquifer in this area, a sample of stagnant water was collected. A localized area of contamination identified in the soil investigation is located upgradient of MW-15. Well MW-15 could also be downgradient of the high perched water area west of the plant which appears to be contaminated based on data from wells MW-5, MW-19, and MW-21. As described in Section 5.3 monitoring wells MW-1A, MW-9, MW-11, MW-15, MW-25, MW-33, MW-41, MW-43, MW-47, MW-49, MW-51, MW-53, and MW-55 were dry or recharged extremely slowly. Consequently, groundwater samples were not collected from these wells per the approved site Sampling and QAPP plans.

Analytical data tabulated in Appendices C and H indicate that the only area where contamination was only found in the deep monitoring wells MW-1, MW-1B, MW-4, and MW-6. Well MW-4 is located near the limit of where the Jackson Formation pinches out, and there is little clay separating the upper and lower aquifers.

The well screen is set near the top of the aquifer at a depth of 73 to 83 feet. Wells MW-1 and MW-1B are located downgradient from MW-4 and were screened from about 90 to 100 feet. Monitoring well 6 (MW-6) is screened at approximately 80 feet below ground surface. At the tested concentrations of TCE in the aqueous phase in the Memphis Sand, there is not believed to be a density component for TCE-water movement; therefore, TCE is not believed to be at a depth beneath the screened intervals of the corresponding deep wells.

The other area where contaminants were found in groundwater from the lower aquifer was in samples taken from the municipal wells. A summary of analytical results from samples collected from the municipal wells is presented in Section 4. The east municipal well is screened at a depth of 278 to 298 feet below ground surface. The west is screened from 241 to 281 feet below ground surface. These screens are more than 100 feet below the base of the Jackson Formation and confining clay.

Samples collected from other deep wells have not been found to contain chlorinated hydrocarbons.

5.5.3 Inorganics in Groundwater

Two metals were identified as possible site constituents at the Collierville Site. These were lead and zinc (Section 4). The selection of these metals was done primarily because values for metals are elevated in the shallow aquifer. However no pattern of contamination or metals source area has been defined in the RI. The old lagoon area may be a potential source of zinc due to the use of zinc phosphate on the site and the discharge of zinc phosphate sludges to the lagoon. However the closure of the lagoon in 1980 appears to have removed these sludges and residual concentrations are low.

Shallow groundwater may be influenced by low pH values which leach otherwise insoluble metal complexes into groundwater and/or by the use of galvanized casings in monitoring wells.

The RI data do not indicate a groundwater contamination plume associated with these metals.

5.6 Fate and Transport Mechanisms

There have been three documented sources of chlorinated hydrocarbon contamination at the Collierville Site as described in Section 1. Residual contaminants from these source areas are still present in specific areas as indicated by the isocon maps presented in Section 5.5. Furthermore, TCE and its degradation products have been identified in groundwater. Groundwater contamination has been identified at the Collierville Site in close proximity to the 1979 spill site and the former sludge impoundment in the shallow aquifer and within the Memphis Sand aquifer. The mechanics for migration of TCE from the source areas to the aquifers are dependent upon solvent specific characteristics, site specific geology and hydrogeology.

Groundwater parameters identified during the Phase III sampling event substantiate that the greatest portion of TCE mass is tied up as soil bound contaminants. Total organic carbons (TOC) at the Collierville site are low, which would indicate that adsorption to site soils would have a limited impact on overall TCE fate and transport. TOC values collected during Phase III of the RI from MW-47 at the 14-16 and 34-36 foot intervals are 692, and 1160 mg/kg dry weight, respectively.

Water chemistry analysis results presented in Table 5-5 appear to be within the typical range for shallow groundwater in Shelby County for each parameter. There are no apparent trends which would be indicative of a significant alteration of site geobiochemistry (as a result of TCE presence).

With respect to solvent characteristics, TCE has been characterized as an immiscible fluid with a density greater than that of water, and is classified as a dense non-aqueous-phase liquid (DNAPL) (Ram, et al. 1990). Figure 5-9 illustrates the possible mechanisms for movement of TCE in both soils and groundwater as determined in the RI (Due to the immediate response and removal of soils impacted from the 1985 spill, the spill area has not been included in Figure 5-9).

Table 5-5
Collierville Site
Groundwater Parameters

	SHALLOW WELLS			DEEP WELLS		
PARAMETER	MW-05	MW-13	MW-29	MW-1B	MW-4	MW-16
Biochemical Oxygen Demand (BOD) (5-day) mg/L	<5	<5	<5	<5	<5	<5
Total Kjeldahl Nitrogen mg/L	<.5	<.5	<.5	<.5	<.5	<.5
Nitrate-N mg/L	1.0	1.8	1.2	2.2	.94	2.0
Nitrite-N mg/L	<.02	<.02	<.02	<.02	<.02	<.02
Ammoniacal-N mg/L	<.05	<.05	1.8	<.05	<.05	<.05
Phosphates (ortho) mg/L	<.05	<.05	.06	<.05	<.05	.33
Sulfates mg/L	6.1	6.8	<.1	<5	<5	<5
Dissolved Oxygen mg/L	4.0	9.0	4.3	3.9	2.4	6.6
pH	7.24	6.19	5.8	6.06	6.26	5.84
Total Organic Carbon mg/L	2.6	2.5	2.9	2.0	1.7	1.4
Dissolved Metals (µg/L)						
Aluminum	ND	ND	195	ND	ND	ND
Barium	176	56	25	88	35	26
Beryllium	ND	ND	1.1	ND	ND	ND
Cadmium	ND	ND	3.0	ND	ND	ND
Calcium	39400	5970	6340	7120	26800	4150
Chromium	ND	ND	9.5	ND	ND	ND
Cobalt	ND	ND	6.4	ND	ND	ND
Copper	8.0	5.0	8.0	5.0	ND	6.0
Iron	292	127	97.7	416	296	341
Magnesium	8820	24200	1720	1650	4060	1310
Manganese	61	5	40	201	25	25
Nickel	ND	ND	8.6	ND	ND	ND
Potassium	1460	ND	817	ND	950	ND
Silver	ND	ND	8.1	ND	ND	ND
Sodium	127000	64400	15900	18400	30200	14800
Vanadium	ND	ND	4.2	ND	ND	ND
Zinc	2030	20	7470	6140	3810	4110
Lead	ND	ND	1.0	62.0	ND	80

Vadose Zone Migration

Soil boring data demonstrate that TCE is migrating through the vadose zone. Residual solvent remains adsorbed within the pore space of the soil particles as TCE migrates through the soil. The total volume of fluid released may be stored in this "residual saturation" phase in the vadose zone unless the soil retention capacity has been reached. The actual distance of downward migration of the fluid phase becomes dependent upon the quantity of material released, the soil retention capacity and the thickness of the vadose zone. Pure phase TCE was not encountered during the investigation, implying that soil retention capacities are not exceeded on the Site. It is unknown whether soil retention capacity may have been exceeded at the time of the releases.)

Further migration of TCE from soils occurs as vapor phase diffusion through soil pores and as downward migration in the dissolved aqueous phase. TCE vapors have a density greater than air and transport to the shallow aquifer may be enhanced by density induced advection in the gas phase (Ram, et al 1990). At the Collierville Site, TCE appears to be reaching groundwater in the dissolved aqueous phase from the infiltration and percolation of rainwater through the soils and through diffusion in the vapor phase.

Shallow Aquifer

Upon reaching groundwater, the further movement of TCE in the shallow aquifer correlates closely with the structure of the underlying aquitard. Subsurface geological investigations at the Collierville Site have tentatively identified a "structural high" (Figure 5-1) in the Jackson clay in the proximity of the former lagoon. The potentiometric surface map of the shallow aquifer reveals groundwater in the shallow aquifer moves radially from this

subsurface feature. The Jackson formation grades from this "high" to the south toward Nonconnah Creek; to the southeast towards Byhalia Road; to the north towards Poplar Avenue; and there is evidence of a slight grade to the west.

Advective transport of contaminants in the aqueous phase from the former impoundment follow natural groundwater flow directions at the site. Groundwater elevations measured in the field and subsequent calculations for flow indicate an average water velocity to the northeast and southeast at an average velocity of 16 ft/day. Groundwater velocity to the southwest and west was calculated to be approximately 11 ft/day. Flow velocities may be further affected as shallow movement continues along the clay surface where the hydraulic gradient increases towards the east.

There is evidence that groundwater in the upper aquifer may be under perched conditions. This is substantiated by the poor recharge to wells MW-1A, MW-9, MW-11, MW-15, MW-25, and MW-43. Significant amounts of groundwater may be present in localized depressions with very little lateral movement except during high recharge periods. However this movement is generally to the southeast, along the top of the Jackson Formation. It is also the path of migration for TCE released in the Main Plant area as well as the likely destination of a portion of the TCE released from the former surface impoundment.

The stratigraphic investigation clearly indicates that shallow groundwater movement to the south and east will eventually migrate to an area in which the Memphis Sand aquifer and the shallow aquifer unit are hydraulically connected.

Memphis Sand

Flow direction in the Memphis Sand is northwest toward the municipal well field. Contaminated groundwater from the shallow unit may therefore be moving across the clay and acting as a point of recharge for the Memphis Sand aquifer. The movement of TCE in the Memphis Sand is expected to follow the zone of influence of the pumping wells at the City Well Field.

TCE contamination has been identified in the Memphis Sand in the southeast portion of the site (MW-1, MW-1B, and MW-4) and the northwest portion at the municipal wells.

The density of TCE in water at maximum water solubilities of (less than 2g/L) is not likely to be sufficient to cause sinking of the plume (Schwille, 1988). Therefore, movement of the contaminants to the well field will be more directly dependent upon the pumping rates of the city well system and the resulting drawdown effects on the Memphis Sand aquifer.

Movement of TCE from the shallow unit to the municipal wells by migration to the area where the units are hydraulically connected is therefore a likely site migration mechanism.

The results of the site investigation suggest that other pathways also exist. Regional geologic data suggest that recharge through the Jackson clay is relatively low because of low permeability across the unit. However, the aquifer pumping test conducted at the site indicated a potential for vertical leakage through this confining clay layer. The vertical leakage or recharge rates, as determined in the aquifer test, range from 0.9 to 18.8 gallons per minute per acre. These rates suggest that leakage through the aquitard may be a

potential pathway for TCE to enter the Memphis Sand aquifer. Furthermore, vertical leakage may be facilitated by sand lenses within the Jackson clay layer (Graham and Parks, 1986).

A third potential pathway has not been confirmed but may also exist. It is possible that contaminated shallow groundwater is moving downward along the City of Collierville municipal well casings into the lower aquifer. These wells were drilled using rotary techniques. Well installation procedures at the time did not require protective surface casings to seal off or protect shallow aquifer systems. Personal communication with Collierville city officials stated that well construction consisted of a gravel pack surrounding the well casing to the ground surface.

The installation of monitoring well 39 (MW-39), which is located west of the former lagoon and the west city well, has shown elevated levels of contamination in the groundwater. The potentiometric surface map for the shallow aquifer indicates that shallow groundwater may move westward from the structural high previously identified in the Jackson Formation (Section 5.3). Consequently, the west city well would be in a direct path of shallow groundwater movement.

5.7 References

Graham, D.D. and Parks, W.S. Potential for Leakage Among the Principal Aquifers in the Memphis Area, Tennessee U.S. Geological Survey, Water Resources Investigations report 85-4299. Memphis, TN. 1986.

Heath, Ralph C., USGS Water Supply Paper 2220, Basic Groundwater Hydrology, (1989).

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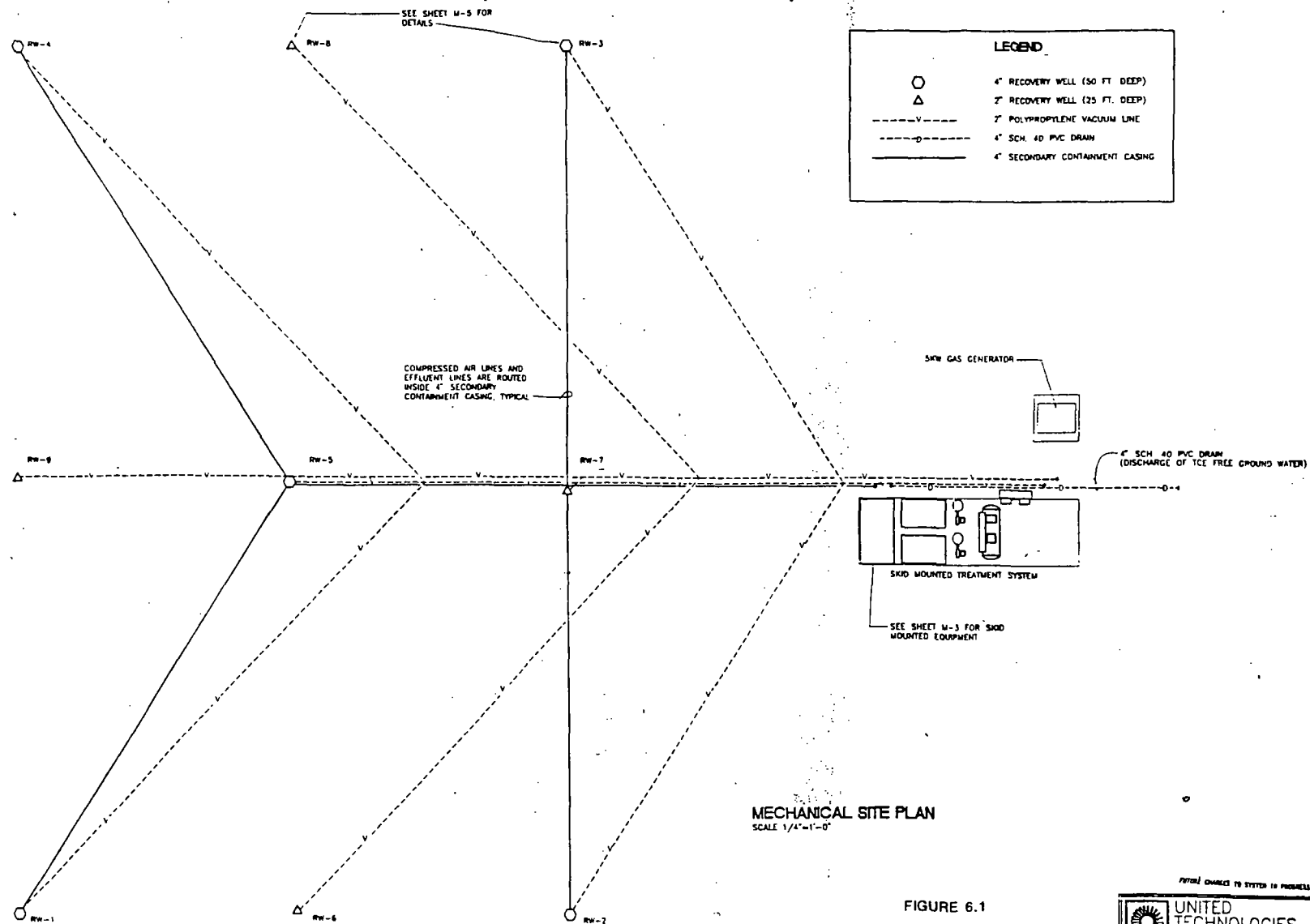
Weston Roy F. Inc., Carrier Corporation Progress Report, March 1986.

6.0 TREATABILITY STUDY

A treatability study is underway at the location of the former surface impoundment, north and west of the manufacturing buildings. The location of the system on the Collierville Site is identified in Figure 1-2. Figure 6-1 depicts layout of the treatability system and extraction wells. The objective of the study is to demonstrate the remediation of both soil and shallow ground water at a source of trichloroethene contamination.

An array of five (5), four (4) inch diameter stainless steel wells were installed to recover contaminated groundwater in the shallow aquifer and allow gas extraction from the unsaturated soil. The wells are screened from the top of the Jackson Clay formation through the lower 20 feet of the fluvial terrace deposits. The wells are constructed utilizing a twenty (20) foot section of 0.010 slot stainless steel screen attached to a section of stainless steel riser completed to ground surface. Individual well locations were determined from the results of the soil gas survey described in Section 5.5 of this report.

Within the arrangement of deeper wells are four (4), two (2) inch diameter stainless steel wells, screened from approximately 15 to 25 feet below grade. The wells are constructed with a ten (10) foot section of 0.10 slot stainless screen attached to a section of stainless steel riser pipe to ground surface.



The shallow wells serve only as shallow soil gas extraction points and do not house pumps. The shallow wells were installed due to the presence of a two (2) foot impermeable layer encountered at approximately twenty-five (25) feet that may serve as a short circuit to the underlying system. In addition, the shallow system would be used to monitor the completeness and effectiveness of the gas extraction phase during the pilot study.

6.1 System Design and Construction

The equipment installed to study remedial treatability is typical of current technology. A schematic of the process is reproduced as Figure 6-2. Process equipment is skid mounted on concrete pads. Extracted fluids are conducted within butt-welded double walled polypropylene tubing in shallow underground trenches to the processing skids. Above grade water bearing equipment is insulated, and exposed piping, the clarifier, and the towers are electric heat traced. The two surge tanks are currently fitted with 6 kilowatt immersion heaters.

Since the original construction of the north remediation system the electrical system and structural components have been modified. The drawings attached herein do not represent as-built conditions. In addition, MW-21 has been incorporated into the treatment system.

6.1.1 Recovery Wells and Pumps

Bottom loading, pneumatic displacement pumps deliver groundwater to a rectangular clarifier tank which overflows to one of two surge tanks. Pump construction is stainless steel and PTFE (Teflon). Motive force is supplied by a 5 horsepower electric compressor at the skid. Pump cycles are actuated from control panel mounted pneumatic timers. Well head solenoids stop air supply to pumps if a float switch does not sense liquid level in the well casing.

Water is conducted from well pumps to the treatment system via a manifold of polypropylene tubing contained within a second, 4 inch diameter polypropylene pipe.

All connections are heat-welded. If free product (trichloroethene) is detected in the clarifier, the system halts operation. The clarifier is installed to collect and remove sediment from recovered groundwater to avoid fouling stripping column packing.

6.1.2 Air Stripper Columns

Water flows by gravity from the clarifier into the first surge tank, and is pumped to the top of a 12 inch diameter random packed stripping tower. Packing is 1 inch nominal diameter Jaeger Tripacks™, loaded to a bed height of 16 feet. The water is actually circulated through the tower at a design rate of 10 gallons per minute (gpm) to attain proper liquid loading in the packing bed. A 2 1/2 horsepower blower provides 167 cubic feet per minute countercurrent air flow in the 12 foot packing section, resulting in a volumetric air to water ratio of about 125.

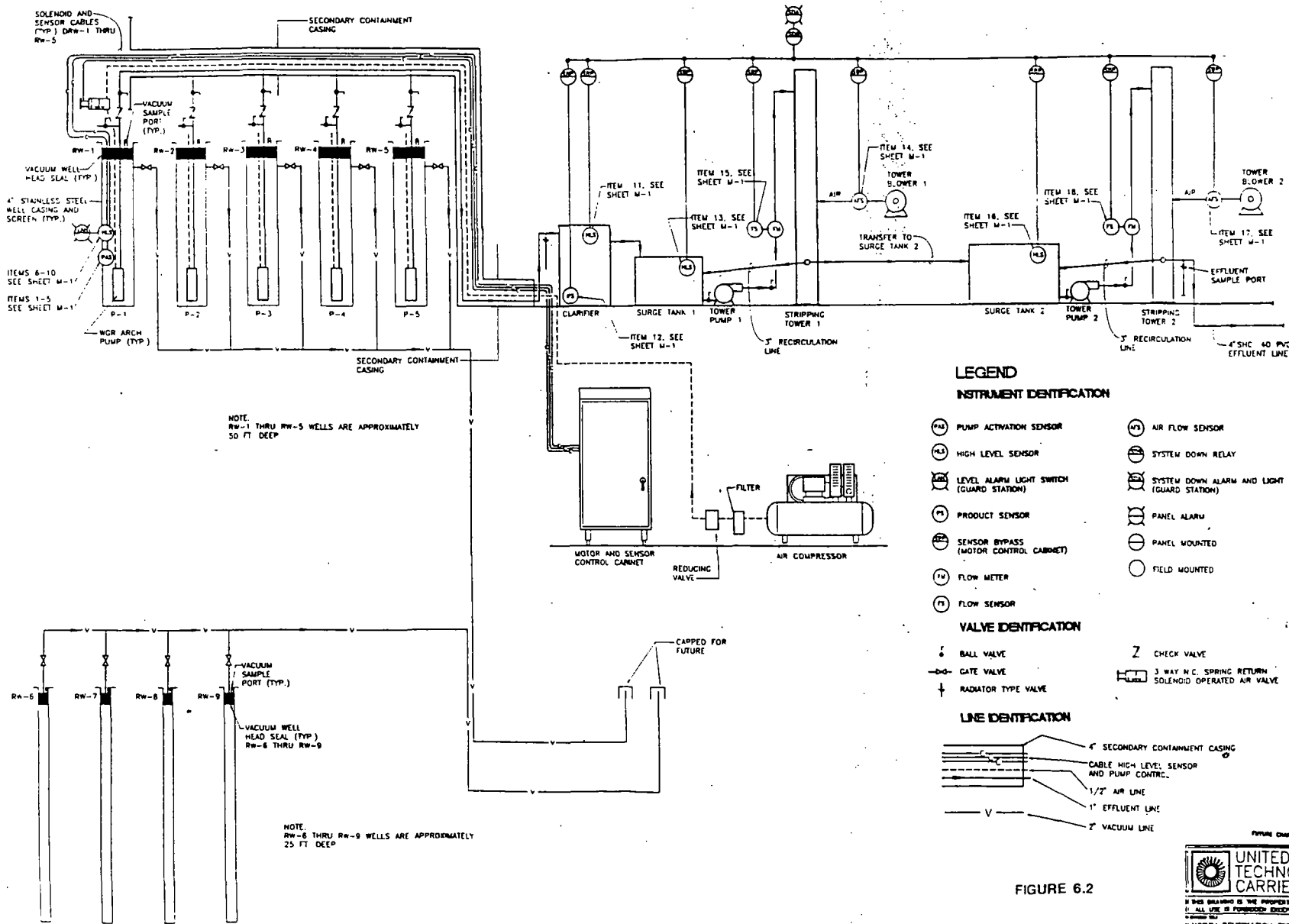


FIGURE 6.2

Water is bled off the first tower discharge at the rate of 40 gallons per day (0.028 gpm) to a second identical surge tank/stripper tower arrangement. Water is discharged from the stream which circulates the second stripping tower to a PVC drain to the sanitary sewer.

6.1.3 Soil Gas Extraction System

Vapor recovery wells are connected to the central skid by a manifold of 2 inch polypropylene pipes. The deep and shallow wells are manifolded separately and each well head has an isolation valve. The installation of a permanent vacuum source is currently underway. Pilot operation of a single deep and a single shallow well were conducted to size a regenerative blower for full-scale treatability at 250 cubic feet per minute and 40 inches of water vacuum. Details of the pilot test are discussed in the following section.

6.2 Results of Initial Tests

To date, the operation of the lagoon treatability study equipment has been limited to brief periods of groundwater recovery and treatment (interrupted by equipment malfunctions), and a two-day pilot test for vacuum extraction.

6.2.1 Groundwater Recovery and Treatment

The recovery well and treatment system operate as designed. Yield of shallow ground water has been minimal. However, removal of trichloroethylene from groundwater is nearly complete, as Table 6-1 illustrates.

Table 6-1
Surface Impoundment Treatability Data

Sample ID	Trichloroethylene $\mu\text{g/l}$	Dichloroethylene $\mu\text{g/l}$
Influent	680	< 10
Effluent	4	< 1

6.2.2 Soil Gas Extraction

A two day test of soil gas venting was conducted at RW-6 (a shallow well), and RW-4 (deep). The test and results are provided in the *Report of Soil Venting Pilot Test, North Remediation Site*, by Westinghouse Groundwater Recovery (attached as Appendix L). Results are summarized as follows:

6.2.2.1

Shallow well: initial TCE removal rate was 35 pounds per day at an applied vacuum of 12 inches Hg. Radius of influence as measured in surrounding wells was about 140 feet.

6.2.2.2

Deep well: initial TCE removal rate was 1000 pounds per day (at 2.8 inches Hg) with a radius of influence exceeding 200 feet. Effects were also seen in the shallow well system.

6.2.2.3

Some indication of gas phase communication with the underlying aquifer was in evidence. During the shallow well venting test, pressures increased from slightly negative (vacuum) to positive in monitored wells. One plausible explanation is a changing (local) level in the Memphis Sand aquifer due to starting or stopping of nearby Town of Collierville production wells. The production wells were not closely monitored during the pilot tests.

A 250-cubic foot per minute blower is currently being installed at the Lagoon Remediation System. It appears that deep well venting will provide the best combination of TCE removal, areal influence, and vacuum stress requirements.

7.0 SURFACE WATER, BIOLOGICAL, AND AIR QUALITY INVESTIGATIONS AND GROUNDWATER USES

A review of groundwater usage on and near the Site and the investigations of surface water, biological, and air impact for the Collierville Site are described in this section of the RI report.

7.1 Surface Water Quality Assessment

The Collierville Site contains one major surface water feature, Nonconnah Creek, which flows from east to west and passes through the southern portion of the Site. Generally rain water on the site drains via overland flow, natural ditches, and man-made culverts to Nonconnah Creek. The portion of Nonconnah Creek on the Site is approximately Mile 25. Nonconnah Creek flows into the Mississippi River at Memphis. The Site portion of Nonconnah Creek is relatively undisturbed and has not been dredged or channelized. The USGS operates a flow recording station at Mile 17.3 of Nonconnah Creek. Data from this station are summarized below. (Reference USGS, 84-1)

Period of Records: 1959-1964, 1969, 1970-1984

Average Discharge: 107 ft³/sec

Maximum Discharge: 9,680 ft³/sec (1975)

Minimum Discharge: 0 ft³/sec (common in most years)

The assessment of Site impact on surface water quality focused on this creek and drainage to it. Surface water samples and sediment samples were collected on the Site to determine surface water quality. The sample locations are shown on Figure 7-1. Three sediment samples were taken in ditches which drain the Site. Samples Ditch-1 and Ditch-2 were collected as grab samples from the ditch which parallels Byhalia Road. This ditch receives storm water from man-made storm water culverts on the Site as well as from culverts on the east side of Byhalia Rd. Sample Ditch-3 was collected from the west ditch. This sample represents sediment from the western and northern sections of the property. No site constituents were detected in any of the ditch samples.

Surface water samples NC-1, NC-2, and NC-3 were also collected. NC-1 is upstream of the Site runoff. NC-2 was taken where the eastern ditch intercepts Nonconnah Creek. NC-3 was collected downstream of the Site. No site constituents were detected in any of the surface water samples.

Additional samples were collected at two locations in Nonconnah Creek in conjunction with a benthic organism study described below. These locations are identified as USS-1, upstream of the site, and DSS-1, downstream of the site. Both water samples and sediment samples were collected at these locations.

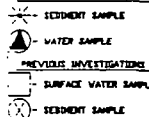
The surface water and sediment samples were negative for TCE and its degradation products in all samples. The absence of positive TCE values is not unexpected since TCE values in soil near the surface (and therefore subject to erosion) are low. In addition, volatilization from turbulent water discharge would tend to minimize soluble TCE transport to Nonconnah Creek.

FIGURE 7-1
WATER QUALITY & BIOLOGICAL
ASSESSMENT SAMPLES
COLLIERVILLE SITE
COLLIERVILLE, TN

DWG DATE: 11/20/91	DWG NAME: CARSIT7
--------------------	-------------------

LEGEND

MONTHLY STUDY LOCATIONS



NOTE: EAST PROPERTY BOUNDARY IS BYHALIA RD.



A benthic organism study of Nonconnah Creek was conducted to determine whether the Site is contributing to biological changes in the Creek. That study is described below.

7.2 Biological Impact Assessment

Two assessments of potential biological impact were made on the Collierville Site. The first is a quantitative study of benthic species diversity in Nonconnah Creek, and the second was a qualitative review of sensitive and endangered species typical of southeastern Shelby County.

The benthic organisms study was conducted by the Biology Department, Memphis State University. Section 7.2.1 is a reproduction of their report.

7.2.1 Benthic Macroinvertebrate Study - Nonconnah Creek

Introduction

A study to determine the population sizes and diversity of species of benthic macroinvertebrates at two sites in Nonconnah Creek, Shelby County, Tennessee, was conducted for Environmental and Safety Designs, Incorporated (EnSafe). Sample Station I was located approximately 30 meters east of the junction of Byhalia Road, Collierville, Tennessee, and Nonconnah Creek; sample Station II was located approximately 363 meters downstream from and west of Station I. See Figure 7-1.

The information obtained in this study is to supplement an investigation to determine the presence of and extent of environmental stress at Station II due to possible releases

of the compound trichloroethylene into Nonconnah Creek at a point between the two sample sites. The investigation was supplemented by water quality and sediment sample collection and analysis by EnSafe personnel.

MATERIALS AND METHODS

Collection of Samples

Samples of benthic macroinvertebrates were taken from two study sites noted in the introductory section above and shown on Figure 7-1. Within each site, six samples were obtained in a riffle area with a Surber square foot bottom sampler. Six petite Ponar grab samples were taken from a pool habitat at each station. Each site was sampled twice, first on June 29, 1990, and then on August 15, 1990. On the second date, an additional riffle sample was taken at a site intermediate between Stations I and II and between the mouths of two tributaries which empty into the creek. On the second sampling date, measurements of dissolved oxygen were made in milligrams per liter using a Yellow Springs Dissolved Oxygen meter, model 57.

Preparation of Samples

Sediment and debris in samplers were placed in a sieve (U.S. standard number 30 mesh), concentrated and transferred to collection jars. Contents from two samplers were combined in one jar. A 5% solution of formalin was added to the samples to fix and preserve specimens for transfer to the laboratory for analysis. In the laboratory, samples were placed in a U.S. number 30 sieve, washed with water, then preserved in 70% ethanol with rose

bengal added to stain organisms. Following staining, specimens were separated from sediments and debris, then transferred to vials of 70% ethanol for preservation and study.

Identification of Specimens

Taxonomic keys and other references used are listed in the Reference section. Larvae of the dipteran family *chironomidae* were selected randomly in group of ten and placed in potassium hydroxide solution to clear head capsules (Mason, 1973).

Cleared specimens were mounted as semipermanent mounts in Permount medium and examined microscopically. Identified subsamples were used to estimate the percentage of individuals in a given sample when numbers of chironomid specimens in a single sample exceeded the number possible to manipulate and identify. Subsamples of oligochaete annelids were placed in lactophenol solution (Hiltunen and Klemm, 1980) for clearing and preservation. Selected annelid specimens in the samples were made, and after the taxa in each sample were determined, a theoretical number of organisms per square meter was derived.

A species diversity index (d) was calculated for each sample using the Shannon-Weaver formula:

$$d = \frac{C}{N} (N \log_{10} N - \sum n_i \log_{10} n_i)$$

where C = 3.321928 (constant which converts base 10 to base 2)
N = total number of individuals in sample
 n_i = total number of individuals in the *i*th species.

Community similarity comparisons were also made (Kotila, 1987).

Percentage Composition of Samples

Oligochaete annelids and insects comprised 100% of the benthic macroinvertebrates in each sample. The taxa, and total numbers of individuals in each taxon from all sample sites, and a theoretical number of organisms per meter square are indicated in Tables 7-1 through 7-9. A composite of all data is given in Figure 7-2 where ratios of annelids and insects in each sample are shown. Figure 7-3 gives the diversity indices for each site during both sampling periods.

Riffle areas typically had fewer organisms per unit area than did pool habitats; however, the number of taxa per unit area and the diversity indices in riffle area at this station consisted of 97% and 99% insects respectively during the two sampling periods. In contrast, samples from the riffle area at Station II contained high percentages of annelids-76% and 91% respectively during the two sampling periods.

Samples from the pool habitats at Station II contained almost pure assemblages of tubificid annelids. Insects constituted 2% and 1% respectively of samples in samples from the pool at this site during the two sampling periods.

Taxonomic Composition and Diversity Indices

Values for Shannon-Weaver species diversity indices were higher in all samples from Station I when compared with the similar site at Station II (Figure 7-3). The riffle area at Station I had the highest diversity value of all sites and contained caddisflies, mayflies, and numerous chironomid midges. Fewer taxa existed at Station II, and these taxa were

distinctly different from those found in the upstream counterpart sites. Numerous snails of the genus *Physa* were also present at Station II: however, these were confined to the water-shoreline interface and did not occur in samples.

Community Similarity Values

The percent similarity between the riffle areas at Stations I and II dropped from 22 % to 3 % between the two sampling dates, while that between the pool habitats increased from 2 % to 73 %. The riffle area between Station I and II showed 8 % similarity with Station I and 73 % similarity with station II.

Additional Observances and Discussion

The benthic invertebrate communities from comparable habitats (riffle compared to riffle or pool compared to pool) are different between the two sampling stations. Substrate type and character apparently do not influence these differences since both sites contain substrate of sand and small gravel dispersed over a bed of clay. Two small streams enter Nonconnah Creek between the two sample sites. The second or westernmost tributary is the assumed source of TCE under study. The first tributary, a city stormwater outlet, enters the creek just downstream of sample site I and appears to have substantial influence upon the nature of the water in Nonconnah Creek. In August, measurements of dissolved oxygen ranged between 9.5 and 10 mg/l in the main channel above the convergence with the first tributary. At and downstream from the confluence, dissolved oxygen levels dropped to levels of 3.4 to 4.0 mg/l, suggesting a heavy organic load contributed by the tributary. Luxuriant growths of bacteria, low levels of dissolved oxygen, a predominance of tubificid annelids, the absence of insect taxa, and the absence of fish below the confluence of tributary one and the Nonconnah suggest that this

FIGURE 7-2 NUMBERS & PERCENTAGES OF BENTHIC MACROINVERTEBRATES IN SAMPLES FROM TWO SAMPLE SITE IN NONCONNAH CREEK, SHELBY COUNTY, TENNESSEE. SAMPLE DATE 1: JUNE 29, 1990; SAMPLE DATE 2, AUGUST 15, 1990.

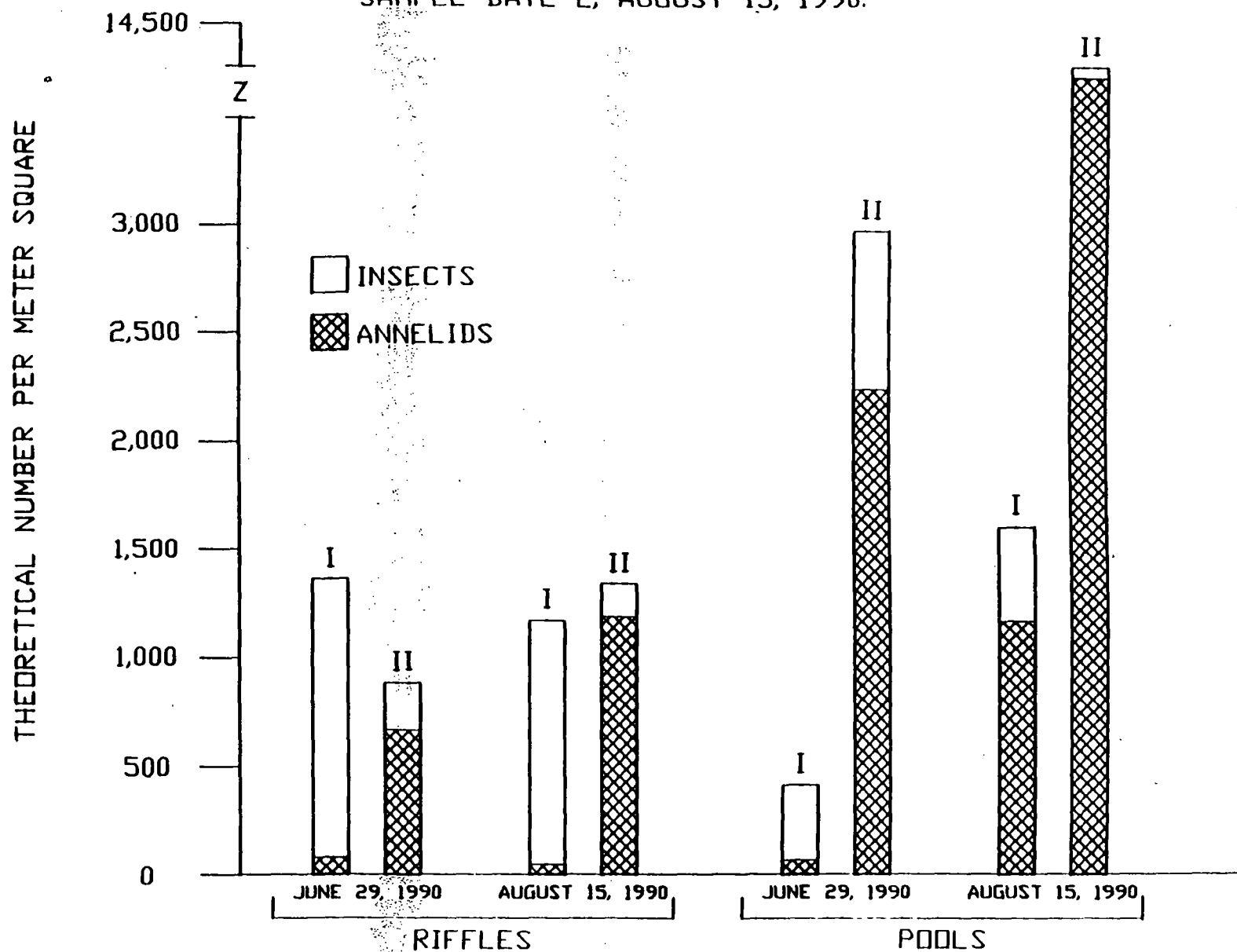
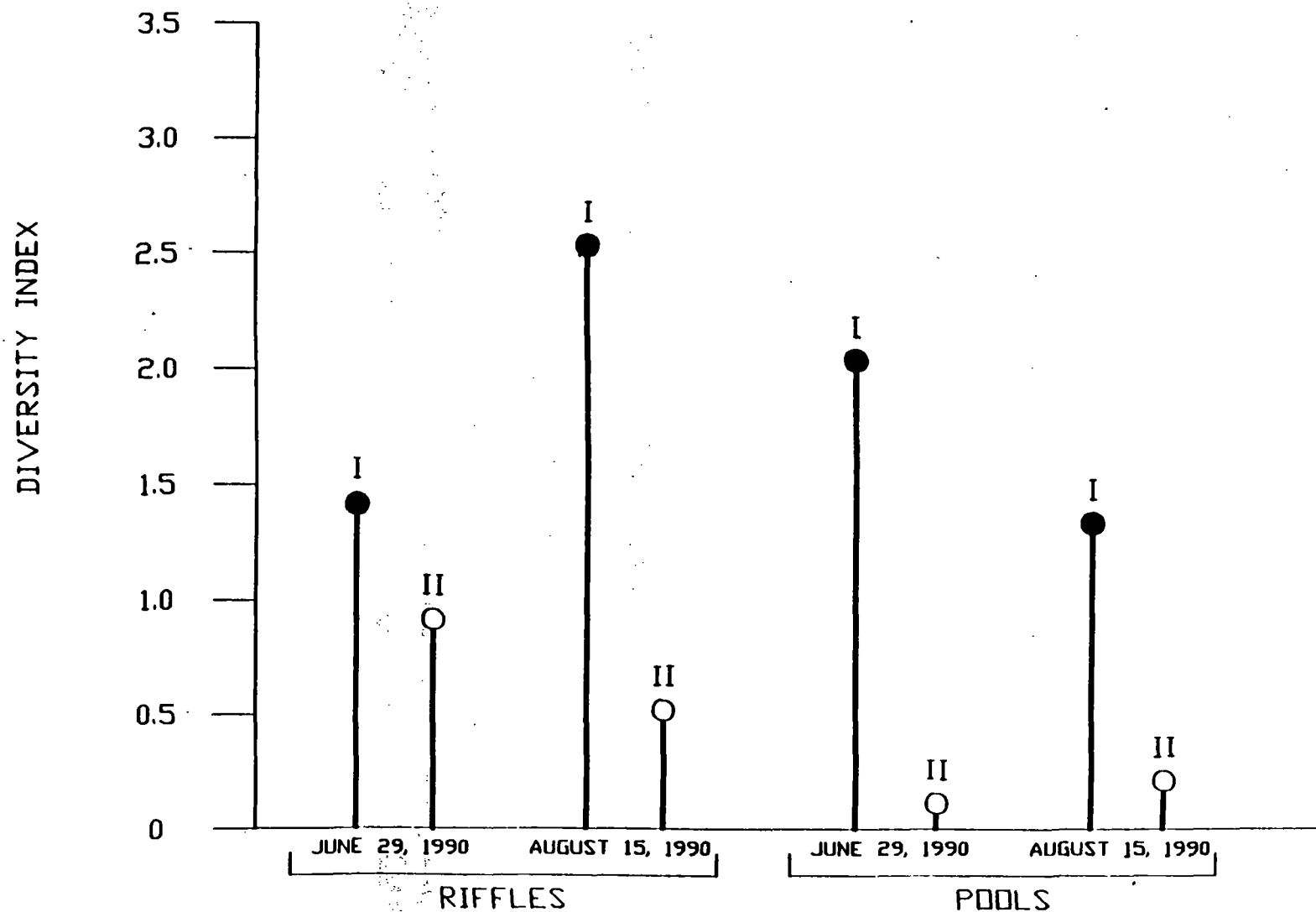


FIGURE 7-3 DIVERSITY INDICES (\bar{d}) FOR BENTHIC MACROINVERTEBRATE SAMPLES FROM NONCONNAH CREEK, SHELBY COUNTY, TENNESSEE. DARK CIRCLES INDICATE SAMPLE SITE I, OPEN CIRCLES REPRESENT SAMPLE SITE II.



tributary is a primary influence on the stream's character. The percentages of similarity between the riffle at Station II and the intermediate site support this suggestion (Table 7-10).

The insect fauna present at Station I, especially the caddisflies, mayflies, and diversity of chironomids, indicates a stream with relatively high water quality. Chironomids of the subfamily *Tanytoderinae* support this. Further, the levels of dissolved oxygen at Station I were high and well above those necessary to support a diverse fauna including fish.

The fauna at Station II changes to one characteristic of water with prolonged low levels of dissolved oxygen, perhaps from organic enrichment. Populations of tubificid worms are tolerant to low oxygen levels similar to those noted during the second sampling period.

Values of diversity indices and percent similarities indicate that the intermediate riffle and Station II are similar, but distinctly different from Station I. We speculate that there is significant perturbation from the first tributary just west and downstream from the junction of Byhalia Road and Nonconnah Creek. Distinct differences in macroinvertebrates between designated sampling Stations I and II must take into consideration effluents into the main channel. The relationship between the two tributaries and their influence on water quality in the main channel may require further study. In addition to water chemistry determinations in each of these streams, further study of the populations of macroinvertebrates found in sites intermediate between sites I and II would be useful. It is generally concluded however that

no TCE/DCE impact has occurred or is likely to occur in Nonconnah Creek. The low species diversity in the stream appears to result from discharges of high BOD materials to the east storm sewer.

7.2.2 Sensitive Ecology Assessment

The Site is open pasture, recent-growth forest. Land use is primarily agriculture and manufacturing, with some areas unused at present.

No threatened and/or endangered species have been identified on or associated with the Collierville Site. The State of Tennessee Department of Conservation does not list any protected or sensitive species in the Collierville Area or in the Site component of Nonconnah Creek.

7.3 Air Quality Assessment

Air quality monitoring was conducted throughout the Remedial Investigation to support the Site Health and Safety Plan. Air monitoring was an essential aspect of all drilling phases. Monitoring was used to determine accumulated TCE vapors in each boring and in background air immediately surrounding the annulus of the borehole for personal health and safety throughout the entire field investigation. A Threshold Limit Value (TLV) of 100 ppm was designated as the maximum level of exposure before "standdown" or an increase in level of protection would be implemented per the investigations Health and Safety Plan.

Table 7-1. Macroinvertebrates from Surver samples in riffle of Station I, Nonconnah Creek, Shelby County, TN (June 29, 1990).

<u>TAXON</u>	<u>THEORETICAL NUMBER PER METER SQUARE</u>
Insecta	
Chironomidae	
<u>Polypedilum</u> sp.....	961
<u>Cryptochironomus</u> sp.....	133
Tanypodinae, Pentaneurini.....	108
Ceratopogonidae	
<u>Probezzia</u> sp.....	4
Trichoptera	
Hydropsychidae	
<u>Hydropsyche</u> sp.....	14
Ephemeroptera	
<u>Baetis</u> sp. 1.....	40
Coleoptera, Dytiscidae.....	4
Hemiptera, Corixidae.....	4
Annelidae	
Naididae.....	47
	Total: 1,315

Table 7-2 Macroinvertebrates from Surber samples in riffle of Station I, Nonconnah Creek, Shelby County, TN (August 15, 1990).

<u>TAXON</u>	<u>THEORETICAL NUMBER PER METER SQUARE</u>
Insecta	
Chironomidae	
<u>Polypedilum</u> sp.....	151
<u>Cryptochironomus</u> sp.....	36
Tanypodinae, Pentaneurini.....	241
<u>Dicrotendipes</u> sp.....	58
Ceratopogonidae	
<u>Probezzia</u> sp.....	14
Ephemeroptera	
<u>Baetis</u> sp. 1.....	522
<u>Baetis</u> sp. 2.....	90
<u>Caenis</u> sp.....	36
Trichoptera	
Hydroptilidae.....	18
Hydropsychidae	
<u>Hydropsyche</u> sp.....	18
Annelida	
Naididae	
<u>Stylaria</u> sp.....	14
Total:	1,198

Table 7-3. Macroinvertebrates from Surber samples in riffle of Station II, Nonconnah creek, Shelby County, TN (June 29, 1990).^a

<u>TAXON</u>	<u>THEORETICAL NUMBER PER METER SQUARE</u>
<hr/>	
Insecta	
Chironomidae	
<u>Polypedilum</u> sp.....	184
<u>Dicrotendipes</u> sp.....	14
<u>Orthocladius</u> sp.....	7
Annelida	
Tubificidae	
<u>Limnodrilus</u> sp.....	641
Total:	<hr/> 846

Table 7-4 Macroinvertebrates from Surber sample in riffle of Station II, Nonconnah Creek, Shelby County, TN (August 15, 1990).

<u>TAXON</u>	<u>THEORETICAL NUMBER PER SQUARE METER</u>
<hr/>	
Insecta	
Chironomidae	
<u>Chironomus</u> sp.....	79
<u>Polypedilum</u> sp.....	40
Annelida	
Tubificidae	
<u>Limnodrilus</u> sp.....	1,231
	<hr/>
	Total: 1,350
<hr/>	
<hr/>	

Table 7-5 Macroinvertebrates from Ponar grab samples in pool habitat of Station I, Nonconnah Creek, Shelby County, TN (June 29, 1990).

<u>TAXON</u> <u>NUMBER</u>	<u>THEORETICAL</u> <u>PER METER SQUARE</u>
<hr/>	
Insecta	
Chironomidae	
<u>Polypedilum</u> sp.....	187
<u>Dicotendipes</u> sp.....	43
Tanypodinae, Pentaneurini.....	101
<u>Paracladopelma</u> sp.....	43
Annelida	
Naididae.....	43
Total: 403	
<hr/>	
<hr/>	

Table 7-6 Macroinvertebrates from Ponar grab samples in pool habitat of Station I, Nonconnah Creek, Shelby County, TN (August 15, 1990).

<u>TAXON</u> <u>NUMBER</u>	<u>THEORETICAL</u> <u>PER METER SQUARE</u>
<hr/>	
Insecta	
Chironomidae	
<u>Cryptochironomus</u> sp.....	288
<u>Polypedilum</u> sp.....	43
<u>Dicrotendipes</u> sp.....	43
Tanypodinae, Pentaneurini.....	43
Ephemeroptera	
<u>Baetis</u> sp. 1.....	29
Annelida	
Tubificidae	
<u>Limnodrilus</u> sp.....	1,123
Total: 1,569	

Table 7-7 Macroinvertebrates from Ponar grab samples in pool habitat of Station II, Nonconnah Creek, Shelby County, TN (June 29, 1990).

<u>TAXON</u>	<u>THEORETICAL NUMBER</u> <u>PER METER SQUARE</u>
<hr/>	
Insecta	
Chironomidae	
<u>Polypedilum</u> sp.....	64
Annelida	
Tubificidae	
<u>Limnodrilus</u> sp.....	2,909
Total: 2,973.	

Table 7-8 Macroinvertebrates from Ponar grab samples in pool habitat of Station II, Nonconnah Creek, Shelby County, TN (August 15, 1990).

<u>TAXON</u> <u>NUMBER</u>	<u>THEORETICAL</u> <u>PER METER SQUARE</u>
<u>Insecta</u>	
Chironomidae	
<u>Polypedilum</u> sp.....	72
Tanypodinae, Pentaneurini.....	72
<u>Dicrotendipes</u> sp.....	14
<u>Cryptochironomus</u> sp.....	14
Ephemeroptera	
<u>Baetis</u> sp. 1.....	14
<u>Caenis</u> sp.....	14
Coleoptera, Dytiscidae.....	14
<u>Annelida</u>	
Tubificidae	
<u>Limnodrilus</u> . sp.....	14,155
Total: 14,369	

Table 7-9 Macroinvertebrates from Surber samples in riffle of Station III, (intermediate), Nonconnah Creek, Shelby County, TN (August 15, 1990).

<u>TAXON</u> <u>NUMBER</u>	<u>THEORETICAL</u> <u>PER METER SQUARE</u>
<hr/>	
Insecta	
Chironomidae	
<u>Dicrotendipes</u> sp.....	23
<u>Polypedilum</u> sp.....	3
Annelida	
Tubificidae	
<u>Limnodrilus</u> sp.....	61
<hr/>	
Total: 87	
<hr/>	

Table 7-10 Percent Similarity Values between Sample Sites I and II, Nonconnah creek, Shelby County, Tennessee.

	<u>June 29, 1990</u>	<u>August 15, 1990</u>
Riffle--Station I and Riffle--Station II	22 %	3 %
Riffle--Station I and Intermediate Riffle	*	8
Pool--Station I and Pool--Station II	2 %	73 %
Riffle--Station II and Intermediate Riffle	*	73 %

*Sample not taken during this period

Two types of monitoring were conducted. During most of the 1987-1988 investigation, a portable infra-red analyzer was used on the Site. The instrument was calibrated to monitor TCE only and was used to measure TCE vapors in breathing zones, contaminant reduction zones, and in "head-space" measurements in soil samples. The infra-red analyzer was supported by measurements made using a photoionization detector (PID) which measured total organic vapor, although with non linear sensitivity to TCE. Table 7-11 summarizes this data.

Background readings were taken throughout most areas of the Site during all field activities from 1987 to 1990. All infra-red and PID readings were negative on the Site except when invasive investigation procedures were underway. During soil borings at the former lagoon area and at the site of the 1979 spill, PID readings were frequently positive. On a number of occasions, the 100 ppm total organic vapor limit in breathing zone criteria for Level C was reached, especially at the former lagoon area.

The onsite PID air quality monitoring established several areas as likely sources of TCE emissions to air during invasive soil activities only. No release of TCE to the atmosphere was detected except when invasive activities such as drilling were being conducted. These areas were: the former lagoon area, the 1979 spill area, especially on the southern and southwestern edges of the Main Plant, and the fence line area adjacent to MW-15. These areas are also those exhibiting positive TCE readings in soil analyses. The absence of positive TCE readings on the Site generally is attributed to likelihood of volatilization of surface TCE in the hot, humid climate, and the elapsed time since the releases of TCE on the Site.

Table 7-11
***Open Borehole Monitoring**
Depth Interval

Boring	0.5-2.0	3.5-5.0	8.5-10.0	13.5-15.0	18.5-20.0	@1 Hour	@ 24 Hour	Bkgd
B1	3.4	8.1	7.5	5.8	(1)	(1)	11	3.4
B2	9.5	5.2	5.8	5.5	5.1	3.8	4.6	9.5
B3	1.8	1.8	2.0	1.4	0.6	0.3	2.0	3.2
B4	0	83	30	45	30	64	146	3.5
B5	0.4	(1)	1.9	3.2	1.3	(1)	4.2	1.4
B6	1.1	3.2	0.2	1.1	2.4	1.8	1.3	0.6
B7	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
B8	0.6	1.1	0.7	0.5	2.4	2.2	(2)	0.1
B9	337	10	845	2396	945	126	11	0.2
B10	2096	0.3	0.6	240	4.2	(1)	161	0.2
B11	1.9	661	2.7	1.8	3.4	7.2	12	0.8
B12	2.7	(1)	2.7	(1)	(1)	(1)	0.9	1.2
B13	117	0.3	0.6	1.7	(1)	(1)	0.8	0.2
B14**	0	0	0	0	0	0	0	0.1
B15	(3)	1.0	0.3	0.6	309	0.3	0.2	0.2
B16	2.4	1.6	1.1	0.7	0.2	0.2	0.2	0.2
B17	(3)	26	(1)	46	2845	(2)	18.6	0.2
B18	(3)	19	159	2.9	211	(2)	16.2	0.2
B19	(3)	7.6	92	111	165	(2)	14.2	0.2
B20	(1)	(1)						

* All readings are in parts per million (ppm), using Infrared spectrophotometer

** Organic vapor detector used (hNu) (1) Low Battery (2) Borehole filled with water

(3) No surface sample collected

7.4 Groundwater Uses in the Vicinity of the Site

The RI has identified TCE/DCE contamination both in the shallow alluvial water table aquifer and in the deeper Memphis Sand aquifer. The water table aquifer has been shown to be poorly productive, yielding little water except in isolated depressions in the Jackson Clay formation. (See Section 5.) However the RI has also shown that the underlying clay allows contaminant migration into the Memphis Sand aquifer both directly through the clay and via recharge areas located on the east and south sides of the site. Therefore contaminants in the shallow unit have a pathway to the underlying Memphis Sand aquifer.

The Memphis Sand aquifer is used as a primary drinking water supply by the Town of Collierville, whose Wellfield #2 is adjacent to the site, and by private residences in rural portions of the area, not served by Town water supplies. Ten private well owners have been located within a radius of one to one and half miles of the site. These residences are shown on Figure 7-4. Figure 7-4 also shows the locations of offsite background wells installed as part of the RI and identified with CMW numbers. All of these wells were sampled for site constituents in September, 1990. Data are reported in Appendix O. No wells were positive for TCE/DCE and no site impact was noted. [Well construction data for these wells could not be located. Because of the low production of the alluvial aquifer, these wells are probably screened in the Memphis Sands.] The private well identified as PW105 is known to be screened in the Memphis Sand. The owner has stated that this well, which serves as a production well for an industry, is capable of producing 400 gpm. Pumping history however has not been recorded.

The Town of Collierville wellfield has been monitored for TCE since August, 1985, following concerns raised as a result of the 1985 site spill of TCE. Data from this monitoring protocol are summarized in Table 7-12. A CLP level analysis for site constituents at this wellfield was conducted as part of the RI. Data from this analysis are presented in Appendix N.

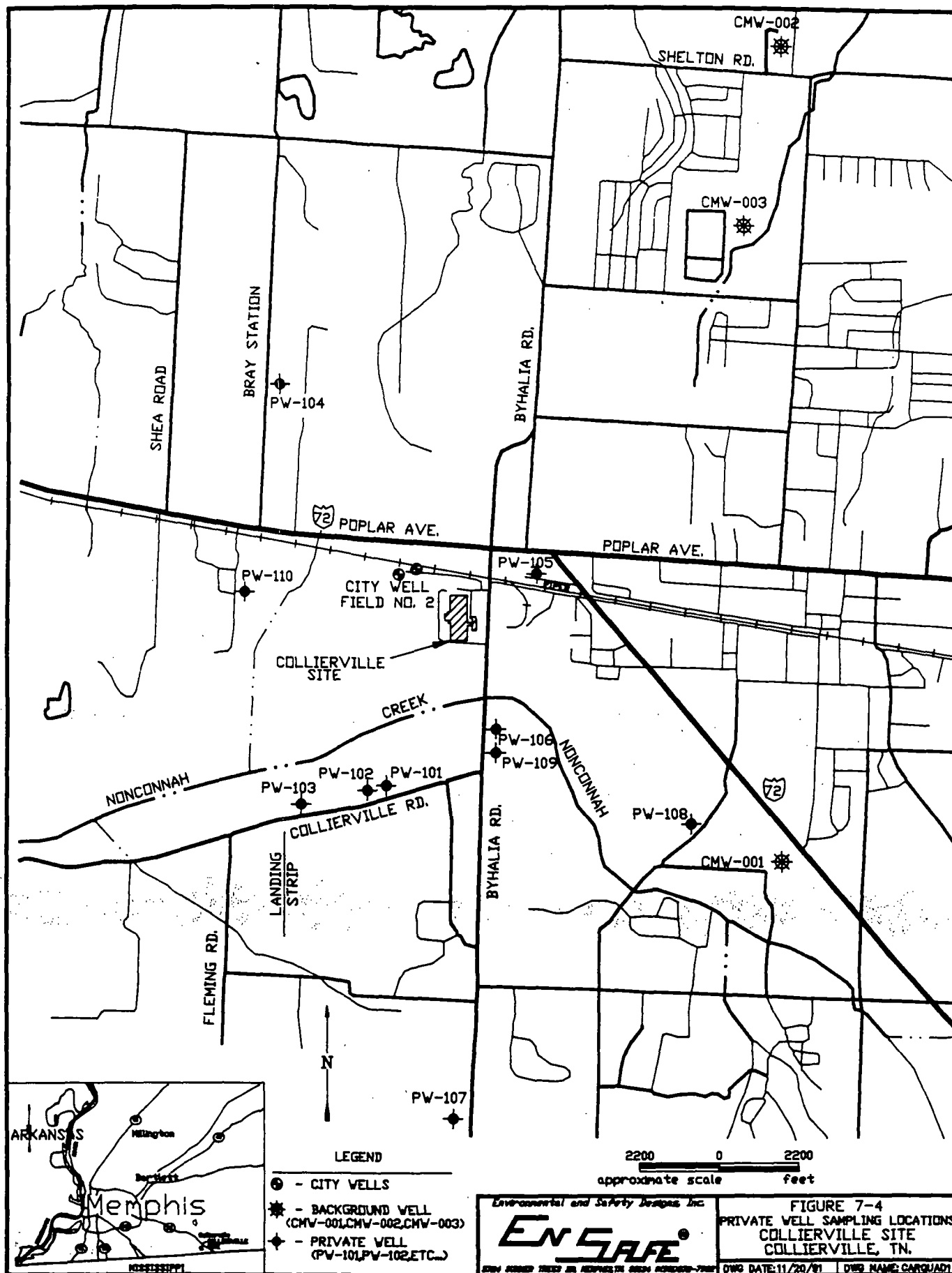


TABLE 7-12
ANALYTICAL RESULTS SUMMARY FOR
TRICHLOROETHYLENE IN WELLFIELD #2

RESULTS ARE REPORTED IN (µg/L)

Sampling Date	East Well	West Well	AA BC	AA AC	AS	QA/QC QUALIFIER
08/27/86	2.0	4.0	—	—		
09/09/86	1.8	<1.0	—	<1.0		
02/24/87	3.3	3.4	0.87	0.68		
04/09/87	3.6	3.5	0.53	0.56		
06/18/87	2.3	2.0	—	0.37		
07/02/87	4.5	3.7	1.1	—		B,R
07/16/87	3.6	4.1	1.4	—		B
07/30/87	3.1	3.9	0.92	—		
08/20/87	4.4	8.1	2.0	—		R
09/04/87	2.1	3.3	0.72	—		
09/17/87	1.7	4.0	0.73	—		
10/01/87	2.2	4.5	0.87	—		
10/15/87	1.8	2.6	<0.20	—		
10/29/87	1.6	3.0	0.35	—		
11/12/87	3.0	0.85	0.51	—		
12/03/87	2.0	5.0	0.85	—		
12/17/87	2.0	5.5	0.63	—		B,R
01/04/88	2.9	7.2	1.6	—		B
01/21/88	2.5	6.7	1.3	—		B
02/04/88	12.0	3.4	2.35	—		B
02/18/88	5.2	10.2	1.75	—		C
03/08/88	3.5	8.3	2.1	—		R,C
03/08/88	2.1	8.5	1.1	—		Recra Env.
03/08/88	5.05	4.48	.99	—		ETC-Memphis
03/23/88	4.2	9.5	2.0	—		C
03/23/88	1.7	7.7	0.77	—		Recra Env.
03/23/88	2.64	8.25	1.65	—		ETC-Memphis
04/28/88	3.0	9.0	2.0	—		
05/17/88	4.0	10.0	3.0	—		
05/31/88	4.0	9.1	2.35	—		
06/13/88	4.4	9.1	2.7	—		
06/27/88	6.0	11.0	4.0	—		

TABLE 7-12, continued
ANALYTICAL RESULTS SUMMARY FOR
TRICHLOROETHYLENE IN WELLFIELD #2
RESULTS ARE REPORTED IN (µg/L)

Sampling Date	East Well	West Well	AA BC	AA AC	AS	QA/QC QUALIFIER
07/19/88	6.0	9.0	3.5	3.0		
08/17/88	7.5	6.9	2.05	1.8		
09/23/88	8.6	8.5	2.4	4.1		
10/07/88	11.0	13.0	4.0	3.4		
11/03/88	10.0	11.0	3.45	—		
11/17/88	19.0	13.0	6.4	—		R
12/02/88	15.0	15.0	4.3	—		
03/08/89	5.2	9.2	1.9	—		
04/10/89	6.5	4.7	0.86	1.1		
05/15/89	11.0	7.1	1.85	1.6		
06/12/89	17.0	9.0	2.45	2.4		
07/12/89	15.0	9.8	2.4	1.5		
08/10/89	25.0	14.0	3.15	3.1		R,C
09/12/89	18.0	14.0	3.6	2.5		R
10/11/89	12.0	23.0	4.8	4.5		R
11/14/89	15.0	—	2.4	2.0		
12/05/89	25.0	—	4.5	3.3		
01/16/90	31.0	—	5.4	4.5		
02/06/90	32.0	—	5.0	3.6		
04/30/90	—	19.0	<0.30	<0.30	<0.30	
05/11/90	—	17.0	0.66	<0.30	<0.30	R
05/18/90	—	14.0	<0.30	<0.30	<0.30	
06/06/90	5.1	14.0	<0.30	<0.30	<0.30	
06/15/90	8.4	20.0		<0.30	<0.30	
06/28/90	7.9	23.0	<0.30	<0.30	<0.30	
07/06/90	8.6	25.0	<0.30	<0.30	<0.30	
07/13/90	9.4	21.0	<0.30	<0.30	<0.30	
08/21/90	9.0	27.0	<5.00	<5.00	<5.00	D
09/18/90	52.0	75.0	<1.00	<1.00	<1.00	
11/19/90	34.0	45.0	<5.00	<5.00	<5.00	D
01/08/91	28.0	43.0	<1.00	<1.00	<1.00	
04/05/91	16.0	70.0	—	—	<0.90	

Notes:

- (1) --- indicates that no samples were collected.
 - (2) AAAC indicates after aeration after chlorination in the treatment plant; AS indicates after stripper.
 - (3) Duplicate analyses are averaged for reporting purposes unless the Relative Percent Difference exceeds 25%. In that event, an 'R' QA/QC qualifier is used and the higher value is reported.
 - (4) QA/QC Data Qualifier Remarks:
 - B: A 'B' qualifier is used if trichloroethylene is reported in the field blank for this sampling event.
 - R: An 'R' qualifier is used if the relative percent differences (RPD) of duplicates for this sampling event exceed 25%.
 - C: A 'C' indicates that the reported value is a corrected value based on subsequent QA/QC review of data.
 - D: A 'D' indicates that detection limits are elevated due to the use of CLP Methodology, not Method 601.
- Lab: Unless otherwise indicated all analyses were performed by CompuChem Laboratories.

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8.0 BASELINE RISK ASSESSMENT

8.1 Introduction

The objective of the baseline risk assessment is to determine the health hazard and risk to humans and the environmental impacts of hazardous substances at the National Priority List (NPL) site as it currently exists. The assessment considers environmental media and exposure pathways that could result in unacceptable levels of exposure now or in the future. The value of the risk assessment as a basis for making remedial decisions is contingent upon an adequate characterization of chemical contamination. The results of sampling investigations conducted by EnSafe and presented in Appendices A through O provide the site characterization data used in this assessment. Tables 8-1 through 8-6 summarize the findings in regard to each media. The Collierville, Tennessee site has two (2) major contaminant source areas as shown in Figures 5-7 and 5-8. The first source area encompasses the portions of the site impacted by the 1979 and 1985 spills. The second source area is the former lagoon located in the northwest section of the site. Figure 8-1 provides a general site schematic.

Composite and grab soil samples from the surface and grab samples from various depths were collected and analyzed for the target compound list/target analyte list (TCL/TAL) of substances during the various RI sampling phases (1989-1991). Over the course of the RI, the list of compounds was reduced to focus on Confirmed Site Constituents (CSCs) which include volatile organics and metals.

A baseline risk assessment to evaluate potential threats to human health and the environment from hazardous substances is mandated by the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) to provide for remedial action at NPL sites that is protective of human health and the environment. The remedial process that includes the definition of risk assessment is described in the National Oil and Hazardous Substances Pollution

TABLE 8-1 Groundwater Summary Table					
Parameter	Sampling Period/ Phase	No. Samples	No. Hits	Range (ppb)	Mean (ppb)
TRICHLOROETHYLENE	12/89	15	10	38-4400	1230
	4/90	17	10	9-14000	2800
	8/90	20	12	20-24000	3850
	11/90	25	13	23-7300	1840
	2/91	23	9	59-8700	2350
	4/91	23	11	8-12500	4400
	8/91	25	15	5-37000	3800
1,2-DICHLOROETHENE	12/89	15	7	7-5300	1530
	4/90	17	6	50-5400	2720
	8/90	20	8	5-3900	830
	11/90	25	9	8-12000	1480
	2/91	23	9	11-12000	1560
	4/91	23	7	7.2-6900	1200
	8/91	25	7	3-370	125
1,1-DICHLOROETHENE	11/90	25	2	9-14	12
	2/91	23	1	---	7.9
	4/91	23	1	---	4.75
	8/91	25	1	---	9
1,1,1-TRICHLOROETHANE	12/89	15	1		44
	4/90	17	0		
	8/90	20	0		
	11/90	25	1		120
	2/91	23	1		32
	4/91	23	2	135.2-824	480
	8/91	25	1	---	69
TETRACHLOROETHENE	12/89	15	0		
	4/90	17	0		

TABLE 8-1 Groundwater Summary Table					
Parameter	Sampling Period/ Phase	No. Samples	No. Hits	Range (ppb)	Mean (ppb)
TETRACHLOROETHENE	8/90	20	0		
	11/90	25	0		
	2/91	23	1		27
METHYLENE CHLORIDE	12/89	15	0		
	4/90	17	2	7-160	85
	8/90	20	0		
	11/90	25	1		7
	2/91	23	2	27-35	31
	4/91	23	6	8-997	210
	8/91	25	7	3-11	6
ACETONE	12/89	15	2	200-320	260
	4/90	17	6	12-860	450
	8/90	20	0	—	—
	11/90	25	1	—	6
	2/91	23	8	7.2-156	45
	4/91	23	4	3.2-790	250
	8/91	25	5	9.1-50	24
CARBON DISULFIDE	12/89	15	0	—	—
	4/90	17	3	9-75	34
	8/90	20	0	—	—
	11/90	25	3	7.58	24
	2/91	23	2	11-78	45
	4/91	23	1	—	17.1
	8/91	25	1	—	11
VINYL CHLORIDE	11/90	25	2	1-5	3
	2/91	23	1	—	3.4
	4/91	23	2	2.27-8.51	5.5
VINYL CHLORIDE	8/91	25	0	—	—

TABLE 8-1 Groundwater Summary Table					
Parameter	Sampling Period/ Phase	No. Samples	No. Hits	Range (ppb)	Mean (ppb)
TOLUENE	11/90	25	1	—	5
	4/91	23	0	—	—
	8/91	25	1	—	7
1,2-DICHLOROETHANE	2/91	23	1	—	43
TRANS-1,3-DICHLOROPROPENE	2/91	23	1	—	46
	4/91	23	0	—	—
	8/91	25	1	—	7.4
BROMODICHLOROMETHANE	2/91	23	1	—	42
DIBROMOCHLOROMETHANE	4/91	23	1	—	824
CIS-1,3-DICHLOROPROPENE	2/91	23	1	—	37
BROMOCHLOROMETHANE	2/91	23	1	—	48
LEAD	12/89	15	3	4-106	42
	4/90	16	9	2.4-152	43
	8/90	20	20	1.4-54.2	19
	11/90	25	21	1.1-278	30
	2/91	26	11	4.9-198	50
	4/91	19	12	3.9-454	134
	8/91	25	17	1-246	80
ZINC	12/89	15	14	2.2-21900	4010
	4/90	16	15	20.6-30300	6800
	8/90	20	19	11-19800	4840
	11/90	25	21	12-146000	11650
	2/91	26	24	10-30500	5600

TABLE 8-2 G H ₂ O - Background Wells					
Parameter	Sampling Period/ Phase	No. Samples	No. Hits	Range (ppb)	Mean (ppb)
Lead	8/90	3	3	4.3-39.5	22
Zinc	8/90	3	3	5.0-1580	990

- *No TCE, DCE or vinyl chloride in any of (3) backgrounds.
- **No site-related source of lead has been identified.

TABLE 8-3 Nonconnah Creek Sediment Samples					
Parameter	Sampling Period/ Phase	No. Samples	No. Hits	Range (ppb)	Mean (ppb)
Lead	6/90	2	2	18.3-23.2	21
Zinc	6/90	2	2	29.3-50	40

- *No TCE, DCE or vinyl chloride in two (2) samples.
- **No site-related source of lead has been identified.

TABLE 8-4 City Well Water Samples					
Parameter	Sampling Period/Phase	No. Samples	No. Hits	Range (ppb)	Mean (ppb)
TRICHLOROETHYLENE	8/90	6	3	2-27	12
	11/90	6	2	34-45	40
1,2-DICHLOROETHENE	8/90	6	0		
	11/90	6	0		
VINYL CHLORIDE	8/90	6	0		
	11/90	6	0		
LEAD	8/90	6	6	1.2-7.6	4
	11/90	6	1		3
ZINC	8/90	6	6	10-272	57
	11/90	6	5	11-115	56

TABLE 8-5 Private Well Water Samples					
Parameter	Sampling Period/Phase	No. Samples	No. Hits	Range (ppb)	Mean (ppb)
Lead	2/91	2	0		
Zinc	2/91	2	2	270-289	280

*No TCE, DCE or vinyl chloride in ten (10) samples 5/90.

TABLE 8-6 Summary Soil Data					
Parameter	Sampling Period/ Phase	No. Samples	No. Hits	Range (ppb)	Mean (ppb)
TRICHLOROETHYLENE		56	8	8-1,200,000	152000
1,2-DICHLOROETHENE		56	3	14-200	78
TETRACHLOROETHENE		56	1		11
1,1,2- TRICHLOROETHANE		56	1		26
TOLUENE		56	4	6-87	40
2-BUTANONE		56	1		190
ACETONE		56	3	12-35	26
LEAD (mg/kg)		39	33	0.67-21.4	7
ZINC (mg/kg)		39	26	3.3-77.8	33

*µg/kg

Environmental and Safety Designs, Inc.

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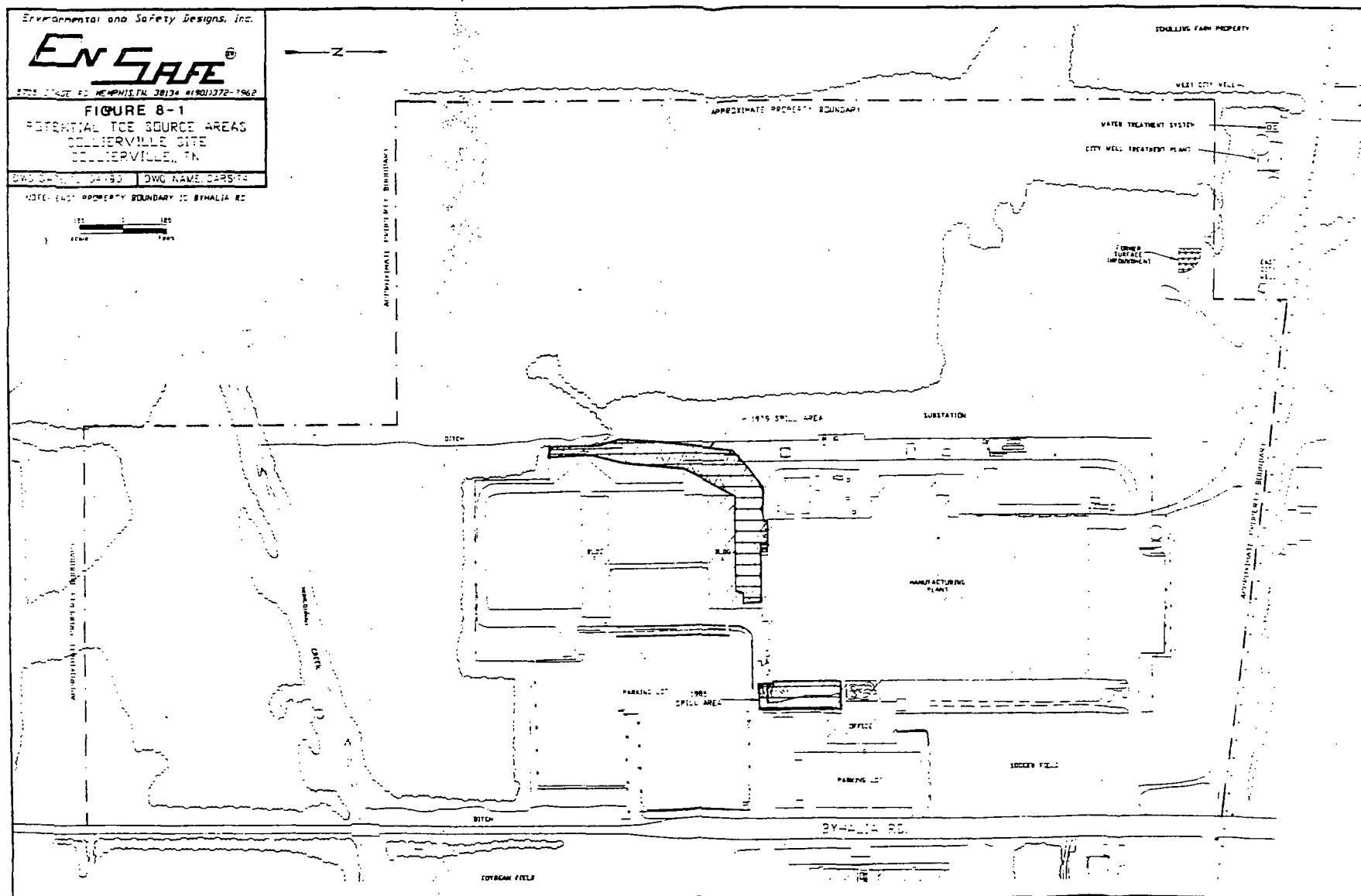
FIGURE 8-1
POTENTIAL TCE SOURCE AREAS
COLLIERVILLE SITE
COLLIERVILLE, TN

DWG DATE: 04-93 DWG NAME: DARS-14

NOTE: EAST PROPERTY BOUNDARY IS BYHALIA RD

0 100 200
FEET

— Z —



Contingency Plan (NCP) and USEPA guidance. Specific guidance on conducting a baseline risk assessment, including a full quantitative risk assessment for likely exposure pathways, is also provided in USEPA guidance (USEPA, 1986; USEPA, 1988a; USEPA, 1988b; USEPA, 1989; and USEPA, 1990). This assessment is prepared consistent with the Risk Assessment Guidance for Superfund (RAGS).

The risk assessment process can be divided into four components:

Contaminant identification - The objective of contaminant identification is to screen the information that is available on hazardous substances present at the Site and to identify contaminants of concern in order to focus subsequent efforts in the risk assessment process. Contaminants of concern are selected in consideration of their intrinsic toxicological properties, their presence in large quantities, their frequency of occurrence and/or their presence in potentially critical exposure pathways (e.g., drinking water supply).

Exposure assessment - The objectives of an exposure assessment are to identify actual or potential exposure pathways, to characterize the potentially exposed populations, and to determine the extent of the exposure. For exposure to occur, four essential elements must exist, i.e. (a) a source and mechanisms of chemical release to the environment, (b) an environmental transport medium (e.g., air, groundwater released chemical), (c) a point of potential contact (exposure point) with the contaminated medium and (d) an exposure route (e.g., inhalation, ingestion) at the contact point.

Toxicity assessment - The objective of the toxicity assessment is to further determine the potential hazard posed by the chemicals of concern for which exposure pathways have been identified. The predicted exposure levels are evaluated relative to internal dose and toxicological responses. Data for each reasonable route of exposure are compared with generally accepted safe levels. Contaminant-specific standards that are applicable or relevant and appropriate

(ARARs) are used when available to determine acceptable levels. When ARARs are not available or sufficiently protective for specific compounds or exposure media, health-based levels are determined by using USEPA reference doses (RfDs) for noncarcinogens and USEPA potency factors (q_1 's) for carcinogens.

Risk characterization - The objective of this final step of the risk assessment is to estimate the overall potential adverse effect by utilizing the exposure information and dose-response data for each exposure scenario. The risk characterization provides numerical estimates of risk and a framework to help judge the significance of the risk and conveys the related uncertainties.

8.2 Contaminants of Concern

Although a number of chemicals were detected in the analyses of site media (Appendices A through O and Tables 8-1 through 8-6), few known hazardous substances were found at a concentration and frequency to be of health concern. Presented in Tables 8-1 to 8-6 are concentrations of contaminants identified in site media. Professional judgement was used to select the chemicals that would be evaluated in the risk assessment from the tabulated list. This judgement was made in keeping with the primary objective of the baseline risk assessment, i.e. to determine if the Site poses a significant hazard now or in the future from any pathway such that the "no action" remedial alternative would be unacceptable. This selection process included the following criteria: (1) the chemical has demonstrated significant toxicity to animal life in published reports, (2) USEPA health-based numbers can be obtained for the chemical, (3) its occurrence is significant, based on frequency, concentration and exposure potential, in regard to the total risk posed by the Site, and (4) these compounds were suggested by Ensafe and reviewed by the USEPA in an October 14, 1990 Draft Remedial Investigation Report. Other factors considered in selection of the chemicals of concern were historical information (site related), mobility, persistence, and bioaccumulation in the environment.

The selected contaminants of concern for the baseline risk assessment are shown in Table 8-7. Seven major hazardous contaminants were considered. Of these, trichloroethylene (TCE) and dichloroethylene (DCE) were the most frequently detected and generally found at the highest concentrations. Although TCE and DCE are the primary contaminants of concern, lead and zinc were evaluated in the Baseline Risk Assessment per agreement with USEPA Region IV, due to their presence in site soils and groundwater. Lead and zinc were included to provide a conservative assessment of the risk posed by the site, however no pattern or source of lead and zinc contamination was established. Lead has not been historically used onsite. As a result, lead and zinc concentrations found in site media were attributed to naturally occurring levels and/or non site-related anthropogenic sources. Vinyl chloride, 1,2-dichloroethane (DCA), and tetrachloroethylene (PCE) were also included in the Baseline Risk Assessment, although they have not been identified at a significant frequency in any site media. Vinyl chloride was included because it is a common degradation product of TCE. Tetrachloroethylene and 1,2-DCA were included on the basis of a request from USEPA, Region IV. Tetrachloroethylene has not been used historically onsite according to the site operator. Vinyl chloride was not identified in any site soils, and groundwater concentrations found were at or near detection limits. Soil and sediments were evaluated in regard to all seven of the above mentioned contaminants. Contamination was not indicated in any surface water samples (Appendix M) and this medium will not be further evaluated in the risk assessment.

In groundwater (of the positive findings); TCE and DCE were always detected in the highest concentration and represent the contaminants of concern with respect to groundwater. As previously discussed, lead, zinc, 1,2-dichloroethane, tetrachloroethylene and vinyl chloride were also evaluated with respect to groundwater. All groundwater (shallow or deep) contaminants having an MCL were considered as contaminants of concern if they were detected in one or more sample wells at an average concentration which equalled or exceeded the current or proposed MCLs.^a

TABLE 8-7 Contaminants of Concern by Environmental Media for the Carrier Company Site	
SOIL/SEDIMENT	
	TCE DCE Vinyl Chloride* PCE DCA Lead Zinc
GROUNDWATER	
	TCE DCE Vinyl Chloride* PCE DCA Lead Zinc

*Vinyl chloride was not detected on-site in any media at a significant frequency, but is considered a common degradation product of TCE.

A larger number of inorganic and organic hazardous substances were detected in soil samples (Table 8-6). No additional contaminants associated with site activity were present at a frequency and concentration to warrant consideration as a contaminant of concern due to their toxicity, detection frequency and concentration.

8.3 Exposure Assessment

The Site is located near a state road in a developed community setting. The site exists in the small growing community of Collierville, Tennessee (pop. ~13000). With the current strict zoning, it is clear that the long-term future use of this Site (after remediation) would be for continued industrial use. The Site is an operating facility and will continue to be so for the foreseeable future. Therefore, it seems prudent to assume that direct and frequent contact by adults in an industrial setting will continue to occur in the foreseeable future. Currently, the Site is used as an operating manufacturing facility. The manufacturing Site is fenced and secured. Infrequent trespassers would pose a likely current exposure scenario with direct exposure to the southern and western portions of the Site by Carrier operating personnel also posing a viable scenario. The nearest residential area is approximately 100' north of the site boundary adjacent to the Collierville municipal well.

None of the nonpaved areas appear to receive heavy foot traffic or obvious pathways of routine exposure¹. However, direct soil or dust contact could result in exposure to trespassers and the workers on site.

Irrigation from the shallow water bearing zone (thin, low yielding zone lying above the Jackson Clay) is not feasible due to the poor production of this unit. Irrigation from the deeper aquifer

¹-Approximately 20% of the 190 acre site is paved or covered by buildings. Approximately 50 to 60% of the contaminant source areas are beneath paved or covered areas.

system (the Memphis sands) would be possible, but would not significantly contribute to overall risk due to the following factors:

- The site is an operating industrial facility.
- The organic contaminants of concern have low bioconcentration factors (< 50) and high Henry's Law constants. The uptake by crops is expected to be minimal.
- The primary metals of concern are zinc and lead. Zinc is a trace element, and both are not available to plant materials for uptake until soil levels reach > 50 ppm.
- Groundwater metals concentrations are not significantly above background concentrations.

Surface waters do not exist on-site or adjacent to the site with the exception of Nonconnah Creek in which no water sample contamination attributable to the site was detected.

No significant direct inhalation exposure on-site is expected as a large portion of the contaminated area is paved/covered. The unpaved areas of the site are far less contaminated and are covered by maintained vegetation (grasses and trees/shrubs). Soil contamination exists at the highest levels at depths from one to five feet (subsurface vs. surface, 0-1'). These factors along with the mild southeast inland climate (average wind speeds of 5-10 mph) contribute to insignificant passive volatilization of site contaminants. Also, the facility has an operating air permit which allows approximately 200 tons of total VOCs per year to be emitted. The maximum combined air stripper output annually has been estimated at < 500 lbs/year (Ensafe, 1991). Passive volatilization from the site would not contribute significantly to VOC air emissions or risk. Active volatilization (such as soil gas vapor extraction) will be addressed in the feasibility study.

Shallow groundwater is not currently used for domestic purposes in the immediate area. The nearest known municipal well is located adjacent to the northwest corner of the Site. The deep groundwater flow is best described as to the northwest (influenced by pumping). Groundwater

contaminant exposure was computed for current and future use of water produced by the Memphis Sand aquifer. Current groundwater exposure pathways exist for local residents supplied by the Collierville municipal well system. Future exposure was assessed via a hypothetical pathway involving residential wells screened in the Memphis Sands. Groundwater contaminant ingestion and inhalation of volatilized groundwater contaminants were considered to determine total exposure through the groundwater pathway. The maximum concentration of each parameter observed in untreated municipal well water was used to compute current risk (conservative assumption). Future resident reasonable maximum exposure (RME) concentrations were established by computing the 95% upper confidence limit mean for each constituent of concern from wells screened in the Memphis Sand aquifer.

The highest groundwater concentrations on-site were generally observed in monitoring wells located in the shallow water bearing zone (which is not used as a potable water source in the Site vicinity). Actual current exposure to groundwater contaminants (through the municipal system) is minimized (or eliminated) by engineering controls (i.e. air stripping of municipal well water prior to distribution). Volatile contaminant concentrations subsequent to the air stripping unit are below MCLs. Use of the shallow water bearing zone and the Memphis Sand aquifer as a potable water source is restricted by administrative controls. The administrative controls currently in place require that any well constructed within the Collierville city limits must be approved and permitted.

The alluvium and fluvial deposits comprise the shallow water table and show inconsistencies throughout the region. Presence or absence of shallow groundwater may be indicative of "perched" zones characteristic of corresponding undulations in the top of the underlying Jackson clay formation.

Graham and Parks (1986) suggest that the areal differences in the Jackson Clay's ability to retard movement between the shallow groundwater and Memphis Sand is directly associated with the

aggregate thickness of clay beds within the unit. However, the confining bed also contains fine sand and sandy silt, which causes local variations in its ability to retard the movement of water between the water-table aquifers and the Memphis Sand. Aggregate thickness of clay beds thicker than 10 feet in the Jackson-upper Claiborne confining bed range in depth from 0-250 feet. As seen from Figure 5-9, the Jackson-upper Claiborne apparently pinches out in the vicinity of Nonconnah Creek resulting in a direct exchange of groundwater between aquifers and is further substantiated by the location of the Collierville Site in relation to the outcrop area of the Memphis Sands.

Based on the difference in hydraulic conductivity and strata physical characteristics between the upper Jackson Clay formation and the lower portions of the Terrace Deposits, it has been postulated that the primary groundwater contaminant pathway to the Memphis Sands aquifer is along the Terrace Deposit/Jackson Clay interface to the Jackson Clay confining layer pinchout (where contaminants may enter the Memphis Sands). Leakage through the confining layer is not expected to be a significant contributor to any contamination of the Memphis Sands aquifer because of the characteristics of the Jackson Clay (high density, low permeability).

Pathways of exposure to concentrations of hazardous substances associated with the Site include current and future direct soil contact via ingestion and dermal pathways, dermal contact, inhalation/bathing contact and ingestion of groundwater at present and in the future (Table 8-8).

8.4 Toxicity Assessment

Four contaminants have been positively identified and quantified at the Collierville Site. They are trichloroethylene (TCE), 1,2-dichloroethylene (DCE), tetrachloroethylene and 1,2-dichloroethane. DCE exists in two isomeric forms, *cis* and *trans*. Isolation of the two isomers in routine analytical determinations is difficult and subject to error. Therefore DCE is usually reported as the total of all isomers. 1,2-DCE is considered an equivocal carcinogen. However the two isomers do exhibit somewhat different toxicities. Therefore, as a conservative approach,

TABLE 8-8
Potential Complete Exposure Pathways for
Risk Assessment Considerations
Collierville NPL Site
Collierville, TN

- Ingestion of and dermal contact with contaminated soil by on-site workers, trespassers (e.g., children), and hypothetical, future, onsite residents.^a
- Ingestion of contaminated groundwater by current municipal water system users (before treatment) and hypothetical, future residents obtaining their water from an on-site well screened in the Memphis Sand aquifer.^b
- Inhalation of chemical vapors emanating from contaminated groundwater during showering by current municipal water system users (before treatment) and hypothetical, future residents obtaining their water from an on-site well screened in the Memphis Sand aquifer.^b

^a Exposure rates (CDI) for ingestion and dermal contact with contaminated soils by future child residents were calculated to be (mg/kg-day) TCE = 4.8×10^{-5} , DCE = 1.2×10^{-6} , Pb = 1.9×10^{-4} , Zn = 8.2×10^{-4} , and PCE = 1.8×10^{-7} (1.5×10^{-8} for carcinogenic effects). Appendix P contains calculations used to derive exposure concentrations (RMEs).

^b Exposure concentrations for chemical intakes for chemical intakes (ingestion and inhalation) related to groundwater were determined as follows:

Current Resident- maximum concentration detected (before treatment) in the Collierville municipal well system water

Future Resident- 95% upper confidence limit mean contaminant concentration detected in monitoring wells screened in the Memphis Sand aquifer

Current after treatment exposure/risk levels were not computed as contaminant concentrations in treated municipal well system water are below analytical detection limits.

the more toxic of the two isomers is used in risk assessment. In general, the *cis*-1,2-dichloroethylene isomer is considered the more toxic. A secondary degradation product of TCE, vinyl chloride (chloroethylene), has not been identified at the Site in any media at significant frequencies. Over a long period of time, however, degradation of DCE to vinyl chloride has been known to occur. Zinc and lead are the metals of concern at the Site, however, observed concentrations do not vary significantly from background, and no site-related source of lead has been established.

In addition to their carcinogenic potential (TCE and vinyl chloride), most of these substances can produce systemic toxic responses at doses greater than an experimentally-determined threshold level. The USEPA has derived Cancer Potency Factor (CPF)² and/or Reference Dose (RfD)³ values for these substances for use in determining the upper bound level of cancer risk and noncancer hazard from exposure to a given level of contamination (Table 8-9).

Drinking water standards (MCLs) have been established for some of the contaminants detected in groundwater impacted by Site activities (Table 8-9). These contaminants include hazardous substances identified as carcinogens and systemic toxicants in published research studies. Critical studies used in their toxicity classification by the USEPA are shown in the Integrated Risk Information System (IRIS) data base. These standards are considered as ARARs for the surface and groundwater at this Site. They are considered "Relevant and Appropriate" since the

²Slope Factor. A plausible upper-bound estimate of the probability of an individual developing cancer as a result of a lifetime of exposure to a particular level of a potential carcinogen.

³Reference Dose. The Agency's preferred toxicity value for evaluating noncarcinogenic effects resulting from exposures at Superfund sites. *See specific entries for chronic RfD, subchronic RfD, and developmental RfD. The acronym RfD, when used without other modifiers, either refers generically to all types of RfDs or specifically to chronic RfDs. It never refers specifically to subchronic or developmental RfDs.

TABLE 8-9
Health-Based Values for Carcinogens (CPF) and
Noncarcinogens (RfD) and ARARs for
Oral Exposure to Contaminants of Concern at the
Carrier Site

Contaminant	CPF _{oral} (mg/kg/day) ⁻¹	CPF _{inhalation} ^a (mg/kg/day) ⁻¹	RfD (mg/kg/day)	Cancer Weight of Evidence	ARAR (MCL as mg/l)
Trichloroethylene (TCE)	1.1x10 ^{-2a}	0.017	NA	B ₂	0.005
1,2-Dichloroethene (DCE)	NA	NA	0.01 ^a	D	0.07 ^b
1,2-Dichloroethane (DCA)	9.1x10 ⁻²	0.091	NA	B ₂	0.005
Tetrachloroethene (PCE)	5.1x10 ⁻²	1.1x10 ^{-10h}	0.01	B ₂ /C ⁱ	0.005
Vinyl Chloride	1.9 ^a	1.8x10 ^{-8h}	NA	A	0.002
Lead	NA	NA	0.0004 ^d	B ₂ /C ⁱ	0.015
Zinc	NA	NA	0.21 ^a	D	5 ^a

^a Not on IRIS 4/91, based on USEPA, 54 & 1-86-046.

^b Based on unit risk for drinking water (est. from CPF/RfD)

^c Not on IRIS 4/91, based on USEPA, ECAO-CIN-P155

^d Calculated unit risk based on 0.015mg/l action level (hazard index = 1) and ingestion rate of 2 liters/day and 70 kg average-body weight

^e Not on IRIS 4/91, based on USEPA, AWQCD, 440/5-80-079 (2^o MCL)

^f Not yet determined or being reconsidered

^g HEAST, 1/91

^h Inhalation Unit Risk assuming IR_h = 15m³/day; BW=70 kg.

NA = Not applicable or not determined (pending)

Cancer Weight of Evidence

A = Human Carcinogen

B2 = Probable Human Carcinogen- sufficient evidence in animals and inadequate or no evidence in humans.

C = Possible Human Carcinogen

D = Not Classifiable as to Human Carcinogenicity

Memphis Sands aquifer is currently used as a domestic water supply. A copy of the IRIS database outputs for each parameter are included as Appendix Q (where available).

8.5 Risk Characterization

The following sections present the risk characterizations for each of the identified exposure pathways. The data and calculations used to establish soil and groundwater RMEs (current and future) are provided in Appendix P.

8.5.1 Groundwater Pathways

The potential risks associated with untreated Collierville municipal well water exposure (using worst-case contaminant concentrations) were quantified (Table 8-10) through a direct ingestion and inhalation risk assessment scenario for the current resident scenario. Future groundwater exposure risk was computed on the basis of a hypothetical residential potable water well installed in the Memphis Sand aquifer. The 95 % upper confidence limit mean (for deep wells over three sampling periods-2nd, 3rd and 4th quarter 1991) for each contaminant was computed as a conservative estimate of the future RME. In each instance (current and future), the combined ingestion and inhalation exposure levels were considered in calculating total groundwater pathway risk (or hazard index). This provides a conservative estimate of the health risks posed by the groundwater ingestion and inhalation pathway (under current and anticipated future conditions). Also, MCLs (ARARs) exist for most of the major contaminants. MCL values generally fall within the concentrations considered protective under the Superfund program. USEPA policy calls for the use of MCLs in assessing risk for contaminants which have MCL Goals of zero. This criteria would apply to lead for which the Maximum Contaminant Limit Goal was established at 0 ppb in the Federal Register, June 7, 1991. Unit risk values (10^{-6}) were calculated from CPF and hazard index (> 1.0) were also calculated. Any exceedence of the MCL (or unit risk/hazard index > 1.0 for drinking water) values by water samples taken within the contamination plume at or downgradient of the point of compliance could represent

TABLE 8-10
Current and Future Resident
Direct Ingestion and Inhalation Groundwater Pathway Risk Associated with the Collierville NPL Site
Collierville, TN

Compound	CPF _{oral} (mg/kg/day) ⁻¹	CPF _{inhalation} (mg/kg/day) ⁻¹	RfD (mg/kg/day)	Current Resident RME (ppm)	Future Resident RME (ppm)	Current Risk (Hazard Index)	Future Risk (Hazard Index)
TCE	0.011	0.017	NA	0.29	0.53	4.7x10 ⁻⁴	2.5x10 ⁻⁴
DCE	NA	NA	0.01	0 ^A	0.117	NA	HI = 0.33
DCA	0.091	0.091	NA	0 ^A	0 ^A	NA	NA
PCE	0.051	1.1x10 ⁻¹⁰	0.01	0 ^A	0 ^A	NA	NA
Vinyl Chloride	1.9	1.8x ^B	NA	0 ^A	0 ^A	NA	NA
Lead	NA	NA	0.0004	0.045 ^B	0.060 ^B	HI = 3.2	HI = 4.1
Zinc	NA	NA	0.21	6.68	6.3	0.87	0.82
Upper Bound Sum of cancer risk: Current Residents 2.5 x 10 ⁻⁴ Future Residents = 4.7 x 10 ⁻⁴							
Upper Bound Sum of hazard indices Current Residents = 4.07 Future Residents = 5.3							

Notes:

NA = Not Applicable

^A indicates that the compound was not identified in samples collected from the subject wells.

^B not significantly elevated above background well concentrations (see Appendix P)

Cancer Risk Formula:

$$\text{Risk} = \frac{[\text{contaminant}] \times \text{EF} \times \text{ED} \times [(\text{CPF}_i \times \text{K} \times \text{IR}_i) + (\text{CPF}_o \times \text{IR}_o)]}{\text{BW} \times \text{AT} \times 365 \text{ days/year}}$$

Non-Carcinogenic Risk (Hazard Index) Formula:

$$\text{Hazard Index} = \frac{[\text{contaminant}] \times \text{IR}_o \times \text{EF} \times \text{ED}}{\text{RfD}_o \times \text{BW} \times \text{AT} \times 365 \text{ days/year}} + \frac{[\text{contaminant}] \times \text{K} \times \text{IR}_i \times \text{EF} \times \text{ED}}{\text{RfD}_i \times \text{BW} \times \text{AT} \times 365 \text{ days/year}}$$

Where:

BW = Body Weight = 70 kg

EF = Exposure Frequency = 350 days/year

CPF_i = Inhalation cancer potency factor = chemical-specific

K = volatilization factor = 0.0005 x 1000 L/m³

IR_o = daily water ingestion rate = 2 L/day

RfD_i = inhalation reference dose = chemical-specific

Risk (hazard index) formulae were obtained from USEPA's Risk Assessment Guidance for Superfund, Volume I, Parts A & B.

AT = Averaging Time = 70 years

ED = Exposure Duration = 30 years

CPF_o = Oral cancer potency factor = chemical-specific

IR_i = daily indoor inhalation rate = 15 m³/day

RfD_o = oral reference dose = chemical-specific

a cause for concern. Samples from several monitoring wells had at least one contaminant that exceeded the current MCL (Tables 8-1 through 8-6).

It is important to note that MCLs are designed to be protective of human health in regard to ingestion of contaminants in potable water supplies. Presently, the shallow water bearing zone and the deep aquifer (Memphis Sands) contain levels of TCE and DCE as well as other VOCs (in much smaller quantities and frequency of detection). TCE, DCE, DCA, and PCE have mean concentrations exceeding their respective MCLs or drinking water unit risk in several monitoring wells. Shallow MW-3 represents the highest downgradient TCE concentration (9000 $\mu\text{g}/\ell$ and 4400 $\mu\text{g}/\ell$ 1,2-DCE) in the shallow water table. The present City Wells monitored show no exceedence of MCLs (due to air stripping of VOCs). Private wells monitored also show no exceedence of MCLs. Future residents (hypothetical) with on-site wells would require levels of VOCs at or below MCLs. Showering, bathing and inhalation of static water in the toilet bowl would not be a significant concern in comparison to direct ingestion, however, the formulae shown in Table 8-10 address risk by combining ingestion and inhalation exposures.

8.5.2 Soil/Sediment Pathway

Direct soil/sediment exposure (ingestion and/or dermal contact) poses a pathway of potential risk. Upper bound cancer risk and toxicity hazard index values were calculated for the contaminants of concern. A summary of these calculated values for current and future Adult Workers is shown in Table 8-11 (see Figures 8-2a and 8-2b). The soil/sediment samples indicate that the surface soil had a wide range of contaminant levels with rather defined areas of greater contaminant concentration (east central portion of the Site).⁴ The vast majority of Site soil contamination exists within the fenced area. Careful perusal of the data presented in Appendices B through G of this Remedial Investigation reveal approximately 85 % of the Site's

⁴The mean concentration of the "hotspot" areas were used as per USEPA, RAGS, 12/89. The greatest areas of contamination are paved or built on. This is a common pattern of contamination in industrial usage sites.

TABLE 8-11 Summary of Risks for Adult Workers from Oral and Dermal Exposure to Contaminants in Soil Carrier Site Collierville, TN		
Soil Contaminant Level (mg/kg)^a	Contaminant	Upper Bound Risk Level^b (or Hazard Index)
35	TCE	1.0×10^{-7}
0.077	1,2-DCE	HI = 7.2×10^{-8}
0	Vinyl Chloride	0 ^c
0	DCA	0
0.011	PCE	1.5×10^{-10} HI = 1.0×10^{-8}
12 ^d	Lead	HI = 2.8×10^{-2}
51 ^d	Zinc	HI = 2.3×10^{-4}
Upper bound Sum cancer risk = 1.0×10^{-7}		
Upper bound Sum hazard indices = 0.028		

^a X concentration in all soils within surface contaminated areas (90-95% C.L. was not calculated as the data are not normally distributed); for metals X concentration assumed to be in all unpaved/uncovered site soils. TCE and 1,2-DCE concentrations are the means for all samples collected at depths of 0 to 5 feet, including screening data from Phase I (see Appendix P).

^b HI (Hazard Index) of > 1 are a cause for concern. Upper-bound risk levels of 10^{-4} to 10^{-6} are considered on a case-by-case basis as to their acceptability by the USEPA.

^c Approximately 89 ppm of vinyl chloride in soil at this site with these assumptions would equal 1×10^{-6} risk level.

^d Tetrachloroethene (PCE) was identified in one soil sample.

^e Lead and zinc concentrations for all samples collected from within five (5) feet of ground surface were used to compute mean values.

FIGURE 8-2a

Equation for Calculating Oral and Dermal
 Chronic Exposure Levels
 Carrier Site

ORAL*

$$\text{Intake (mg/kg/day)} = \frac{CS \times IR \times ABS \times CF \times FI \times EF \times ED}{BW \times AT}$$

DERMAL

$$\text{Absorbed dose (mg/kg/day)} = \frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

- CS = Chemical concentration in soil (mg/kg)
- IR = Ingestion rate (mg soil/day)
- CF = Conversion factor (10^{-6} kg/mg)
- FI = Fraction ingested from contaminated source (unitless)
- EF = Exposure frequency (days/years)
- ED = Exposure duration (years)
- BW = Body weight (kg)
- AT = Average time (period over which exposure is averaged - days)
- SA = Skin surface area available for contact (cm^2/event)
- AF = Soil to skin adherence factor (mg/cm^2)
- ABS = Absorption factor (unitless) (equals 1 for ingestion pathway and 0.01 for the dermal contact pathway)

*Oral and dermal doses are additive as the chronic exposure calculations for each pathway incorporate an absorption factor to arrive at absorbed dose from administered dose. The assumption was made that 100% of orally ingested contaminants are absorbed. As a result, the absorption factor of 1 was used to convert intake dose to absorbed dose. Similarly, an absorption factor of 0.01 was used to compute dermal absorbed dose from administered dose. The sum is then multiplied by the CPF to obtain the upper bound risk. The sum is divided by the RfD to obtain the Hazard Index (unitless) for noncarcinogens.

FIGURE 8-2b

Example Calculation of Table 8-11 (PCE)

A.

$$I_{oral} = \frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$$

$$I = \frac{0.011 \times 50 \times 0.000001 \times 1 \times 250 \times 70}{70 \times (20 \times 365)}$$

$$I = 5.4 \times 10^{-9}$$

B.

$$D_{absorbed} = \frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

$$D = \frac{0.011 \times 0.000001 \times 2300 \times 2 \times 0.01 \times 250 \times 20}{70 \times (20 \times 765)}$$

$$D = 4.95 \times 10^{-9}$$

C.

$$\Sigma = D + I$$

$$\Sigma = 1.04 \times 10^{-8}$$

D.

$$\Sigma \text{ Risk} = \Sigma \times \text{CPF (or } \Sigma + \text{RfD)}$$

$$\Sigma \text{ Risk} = 1.04 \times 10^{-8} + 0.01$$

$$\Sigma \text{ Risk} = 1.0 \times 10^{-6}$$

total soil area is not paved. Volatiles in the soil tend to lie below the paved areas in 'hotspots' which constitute ~28% of the total site area. For the purpose of this baseline risk assessment, the arithmetic average of the contaminants of concern concentration identified in soil samples collected from depths of zero to five feet (surface soils) was used for risk computations. All surface soil samples were collected using the purposive approach, and the "hotspots" for soil were delineated. As a result, the "hotspot" approach outlined in USEPA, RAGS, 12/89 was used to establish the Reasonable Maximum Exposure (RME) to soil contaminants. This approach was justified by assuming conservative estimates for the area of contaminated soils (plant area and lagoon area, ~15-20% of the total site area) and that 100% of the soils ingested and/or contacted dermally were from the 'hotspot' areas. The handling of the data is consistent with the RAGS manual.

The relevant soil exposure scenarios for this site are considered to be adult workers exposed through the combined pathway of ingestion and dermal adsorption of contaminated soil (Table 8-11). Trespassers would be expected to spend a minimal amount of time on-site compared to adult workers and therefore should be adequately protected based on the occupational exposure calculations. Future residents and pica children would not be exposed significantly to VOCs in surface soils (Table 8-12). The 0-1' soils do not retain VOCs due to volatilization, and as a result, VOCs would not be available for exposure. Risk calculations were, however, performed using VOC mean values for the upper five (5) feet of soil. These means were applied to all potential exposure scenarios. Metals concentrations could pose a risk to potential future residents and small children. These risks are presented in Table 8-12 as Hazard Indices (see Figures 8-2a, 8-2b, and Figure 8-3).

8.5.2.1 Specific Soil Pathway Observations

TCE accounts for >99% of the total upper bound cancer risk for on-site soils. The calculated Upper Bound Risk Level for Adult Workers was 1.0×10^{-7} while the Upper Bound Risk Level for Future Child Residents was 5.2×10^{-7} (see Tables 8-11 and 8-12, respectively). TCE is found

TABLE 8-12 Summary of Risks for Potential Future Child Residents from Oral and Dermal Exposure to Contaminants in Soil Carrier Site Collierville, TN		
Soil Contaminant Level (mg/kg)^a	Contaminant	Upper Bound Risk Level^b (or Hazard Index)
35 ^c	TCE	5.2×10^{-7}
0.077 ^c	1,2-DCE	HI = 1.2×10^{-4}
0	Vinyl Chloride	0 ^e
12 ^f	Lead	HI = 5.0×10^{-1}
0	DCA	0
0.011	PCE	8×10^{-10} HI = 1.7×10^{-6}
51 ^f	Zinc	HI = 3.9×10^{-3}
Upper bound Σ cancer risk = 5.2×10^{-7g}		
Upper bound Sum hazard indices = 0.5		

- ^a X concentration in all site soils within five (5) feet of ground surface where TCE and/or DCE has been identified; assume 100% of Future Child Resident soil exposure is in contaminated area on-site
- ^b HI (Hazard Index) of >1 are a cause for concern. Upper bound risk levels of 10^{-4} to 10^{-6} are considered on a case-by-case basis as to their acceptability by the USEPA.
- ^c 1×10^{-6} risk (with these assumptions) in soil ~ 150 ppb vinyl chloride
- ^d Lead is not bioavailable to humans below approximately 200 ppm in soils. The USEPA has recommended a soil lead level of 500 to 1,000 ppm at NPL sites (to protect from direct contact and ingestion). A site-specific lead exposure model is currently being tested by the USEPA (USEPA/ECAO 6/91, personal conversation with Dr. Harlal Choudhury)
- ^e TCE and 1,2-DCE data from samples collected prior to the initiation of the Remedial Investigation were included. Below detection limit results were not used in the calculation of means.
- ^f Lead and zinc concentrations for all samples collected from within five (5) feet of ground surface were used to compute mean values.
- ^g Example calc. are the same as Figure 8-2b except child assumptions (Figure 8-3) were used.

NOTE: It was assumed that in the future the entire site will be unpaved and uncovered.

<p align="center">FIGURE 8-3 Assumptions for Exposure to Soil Contaminants of Concern at the Carrier Site* Collierville, Tennessee</p>		
Oral Exposure	Adult Worker	Future Child Resident
Daily soil ingestion level	50 mg	200 mg
Fraction of time onsite in contaminated area	100% (VOCs)	100%
Portion of ingested contaminant absorbed	100%	100%
Days per year onsite	250 days	350 days
Years onsite	20 years	6 years
Body weight	70 kg	15 kg
Lifetime	70 years (carcinogens) 20 years (non-carcinogens)	70 years (carcinogens) 6 years (non-carcinogens)
Dermal Exposure		
Skin area contaminated	2300 cm ²	2430 cm ²
Soil adherence per cm ² of skin	2 mg	2 mg
Dermal Absorption Rate	1.0 ^b	1.0 ^b
Days per year onsite	250 days	250 days
Years onsite	20 years	6 years
Body weight	70 kg	15 kg
Lifetime	70 years (carcinogens) 20 years (non-carcinogens)	70 years (carcinogens) 6 years (non-carcinogens)

*USEPA, RAGS, 12/89 and/or USEPA, Std. Default Exp. Factors, OSWER Dir. 9285.6-03, 3/91.

^bVOCs 1.0%; includes soil matrix effect

in the greatest concentrations on the east central (historic spill location) and northwest (former lagoon area) portions of the Site (approximately 20% of the on-site area). The unpaved/uncovered percentage of each source area was computed in order to assess the potential for ingestion of or dermal contact with contaminated surface soils with respect to Adult Workers (volatile contaminants only). As a result of the differences in distribution of metals (lead and zinc) compared to volatile contaminants over the site, the entire unpaved/uncovered fraction of the site was used to assess the risk to Adult Workers posed by these parameters. Adult workers were assumed to contact the site uniformly. Conservative estimates were made of the total exposed areas in which contaminant exposure could occur (based on contaminant distribution). The occupational exposure durations calculated for this area of the Site are also conservative. It also should be noted that occupational exposures are intermittent and not continuous. This is one toxicological basis for the less conservative TLV values versus risk values. Again, the conservative assumption of continuous exposure was used and TLVs were disregarded.

In order to assess the risk to Future Child Residents, it was assumed that the entire site would be uncovered and unpaved in order to establish conservative exposure estimates (for both volatiles and metals). For calculation of the risk to Future Child Residents, it was also assumed that 100% of the ingestion and dermal contact exposures would occur within contaminated surface soil zones. This is a highly conservative assumption; however, it serves to provide an additional buffer factor with respect to computed risk to Future Child Residents.

The average value of each contaminant in soil samples collected from the upper five (5) feet of soil was used to assess risk. This value was used in order to provide a more representative assessment of the Upper Bound Risk Level (or Hazard Index) as it is not reasonable to expect contact with contaminated soils below this depth during normal occupational or residential activities. The potential does exist for short-term occupational exposure to soils at or near a five (5) foot depth in the event of required maintenance or repair work associated with underground utilities. Because these exposures are likely to be of short duration, it was determined that the

Adult Worker soil ingestion and dermal contact exposure scenarios would be protective of workers exposed under these atypical conditions.

The assumptions used for computing exposure to soil contaminants are provided in Figure 8-3.

8.5.2.2 Soil Cleanup Levels for Groundwater Protection

USEPA Center for Environmental Assessment Modelling (CEAM) provided their Exposure Assessment Multimedia Model (MultiMed) for use in determining necessary soil clean-up levels for protection of groundwater. The MultiMed model is used to predict groundwater contaminant concentrations downgradient from a landfill source based on "leachate" concentrations. If acceptable contaminant levels are known for the downgradient groundwater plume, initial acceptable leachate concentrations can be found by MultiMed through trial and error input. Acceptable leachate concentrations can then be used to derive acceptable soil clean-up levels using contaminant mass balance data and vadose zone characteristics.

The conceptual site model for the Collierville NPL site (as developed in the RI) was used as the basis for assessing the potential for contaminant migration to the underlying Memphis Sands aquifer. The computed soil cleanup goal for groundwater protection is 500 $\mu\text{g/kg}$ TCE. This is the average soil concentration (within soil contaminant 'hot spots') which must be achieved to ensure that contaminant (TCE) concentrations in the Memphis Sands do not exceed applicable ARARs (i.e. MCL). Soil 'hot spots' as defined herein encompass approximately 20 percent of the total site area.

The results of the application of MultiMed and contaminant mass balancing for the determination of soil cleanup goals at the Collierville NPL site are presented in Appendix R.

8.6 Ecological Considerations

No U.S. Dept. of Interior lands or federally listed endangered species of wildlife were identified at the Site.

The nature of the Site is such that avian or terrestrial wildlife would not be drawn to the Site. Dr. Jim Payne and Chester Fiegel of Memphis State University performed a limited ecological study found in the 1990 RI for this site (see Section 7 of the RI). Data to date indicate no significant adverse ecological impacts from the present soil or groundwater contamination. This preliminary survey does not rule out ecological impacts to aquatic and terrestrial species through contaminated food chain mechanisms. However, TCE is not biocumulative and as a result, it is not expected to cause deleterious food chain effects based on currently available data.

8.7 Risk Uncertainty

There is a generally recognized uncertainty in human risk values developed from experimental data. This is primarily due to the uncertainty of data extrapolation in the areas of (1) high to low dose exposure, and (2) animal data to human experience. The site-specific uncertainty is mainly in the degree of accuracy of the exposure assumptions. Most of the assumptions used in this and any risk assessment have not been verified. For example, the degree of chemical absorption from the gut or through the skin or the amount of soil contact is not known with certainty. Accepted default values provided in USEPA guidance were used here. However, it should be noted that little data or guidance is available on the dermal absorption of particulate-adsorbed contaminants. In the risk assessment conducted for the Site, the dermal pathway yielded a significant contribution to the calculated direct exposure risks (an overestimate of risk).

In the presence of such uncertainty, the USEPA and the risk assessor has the obligation to make conservative assumptions such that the chance is very small for the actual health risk to be greater than that determined through the risk process. On the other hand, the process is not to yield absurdly conservative risk values that have no basis in reality. That balance was kept in

mind in the development of exposure assumptions and pathways and in the interpretation of data and guidance for this baseline risk assessment.

8.8 Risk Summary

The primary exposure pathways for contaminants present at this NPL site were determined to be:

- Direct ingestion of contaminated soils by the current Adult Worker population and Future Child Residents of the site.
- Dermal contact with contaminated soils by the current Adult Worker population on-site and Future Child Residents of the site.
- Ingestion of contaminated groundwater and inhalation of contaminants volatilized from groundwater (without treatment) which has been impacted by past contaminant releases onsite for both current and future residents.

The major soil contaminants are not uniformly distributed over the site surface but exist in areas of varying concentrations. This pattern of contaminant distribution was managed for risk assessment purposes by considering the risk from exposure to the unpaved/uncovered portions of the site which have been shown to have soil contamination in the upper five (5) feet of soil. Conservative estimates of the total area of the site which has surface contamination were used to assess current Adult Worker exposure to volatile contaminants of concern (100%). The entire unpaved/uncovered area of the site was used to assess the risk to Adult Workers posed by metals (lead and zinc) in the site surface soils (assuming homogeneous metals concentrations over the entire unpaved/uncovered portion of the site). In both instances (for Adult Worker exposure), the workers were assumed to contact the site uniformly (see Section 8.5.2.1). In order to assess the risk posed by the site to Future Child Residents, it was assumed that the entire site will be unpaved and uncovered, and that all potential ingestion and dermal contact exposures would occur within contaminated surface soil zones.

The mean concentration of a contaminant found in samples collected in the upper five (5) feet of soil was considered as the exposure level (for both soil ingestion and dermal contact scenarios).

The result of the risk calculation for the major soil contaminants, using the above stated assumptions, are shown in Tables 8-11 and 8-12. In Table 8-11, the risk to workers from the major contaminants of concern is shown. In Table 8-12, the risk to future child residents is shown. Since the risk values represent a fraction of time exposed uniquely to a contaminant in the contaminated areas the sum of these risk values (5.2×10^{-7}) approximates the child's upper bound risk. This value does not represent the total risk from the Site since neither 100% of a future child resident's on-site time nor exposure to all site contaminants are accounted for. However, the remaining unaccounted risk is presumed to represent an insignificant additional risk. Vinyl chloride has been determined to pose little or no current risk to human health due to the infrequency of detection and low concentrations identified.

These data indicate that exposure to contaminated surface soils onsite does not pose an upper bound risk level greater than the 10^{-6} point of departure for current site workers or future resident children onsite. The Site does not pose a risk greater than the accepted range of 10^{-4} to 10^{-6} for onsite current or future workers.

The Hazard Index values as shown (Tables 8-11 and 8-12) indicate that on-site exposures would not result in noncancer toxicity to the current adult workers or future child residents on-site. As a result, lead and zinc are not considered to pose a significant health risk from the standpoint of soil ingestion or dermal contact.

Table 8-10 shows that, assuming worst-case conditions, Site groundwater may pose a significant carcinogenic and non-carcinogenic risk to current and future residents. The upper bound cancer risk to current residents posed by the groundwater exposure pathway is 2.5×10^{-4} . The Hazard

Indices for lead and zinc are 3.2 and 0.87, respectively under the current resident scenario. These values indicate that a non-carcinogenic risk may be posed to current residents (lead). Maximum contaminant concentrations in untreated Collierville municipal well system water were used to compute current risk (and hazard indices).

The upper bound cancer risk to future site residents from the groundwater exposure pathway is 4.7×10^{-4} . The hazard indices for DCE, lead and zinc are 0.33, 4.1, and 0.82, respectively under the future resident scenario. The contaminant concentrations (RMEs) used to compute risk (and hazard indices) to future site residents were the 95 % upper confidence limit mean values for all deep monitoring wells computed over three quarterly sampling periods. As a result, the risk levels computed are highly conservative estimates.

It is worthy of mention that lead concentrations (which pose the primary non-carcinogenic risk) observed in the Memphis Sand monitoring wells are not significantly different than those observed in background wells. The 95 % upper confidence limit mean for lead in wells CMW-001 and CMW-002 (background wells) over the same monitoring period was 0.061 mg/L (versus 0.060 mg/L in the Memphis Sand wells). The maximum concentration of lead observed in untreated municipal well system water was 0.045 mg/L (over the same sampling period). As a result, the hazard indices computed for lead (under current and future exposure scenarios) cannot be directly attributable to the site, and may result from the natural lead content of the aquifer material or non site-related anthropogenic sources. Appendix P provides data tables and statistics used to establish RMEs as well as background well 95 % upper confidence limit determinations.

The shallow water bearing zone is not currently used as a source of potable water nor is it anticipated to be used as a potable source in the future. Therefore, it was not considered a viable future exposure pathway.

The Memphis Sands aquifer which lies below the shallow water bearing zone (separated by the Jackson clay unit) is used as a potable water source for the City of Collierville. Engineering controls (i.e. air stripper) are currently in place on the Collierville municipal well system to remove contaminants prior to distribution. As a result, actual current resident exposure to groundwater contaminants is negligible.

In light of the current and potential future groundwater uses, efforts should be made to preclude the migration of volatile contaminants from the shallow water bearing zone to the Memphis Sands in order to maintain (and over time enhance) the quality of the Memphis Sands aquifer.

8.9 Remediation Goals

8.9.1 Soil Cleanup Levels for Direct Exposure

Tables 8-11 and 8-12 show that no risk exists on-site for direct soil exposure for the VOC contaminants of concern for a 10^{-5} to 10^{-6} point of departure under current conditions. These levels were derived using the oral and dermal exposure assumptions utilized in the equations shown in Figure 8-3 to calculate the upper bound risks for volatile contaminants at the Site.

Although inorganic parameters were shown to pose little or no human health risk on-site, hazard indices were computed for lead and zinc. The highest Hazard Index value (5.0×10^{-1}) applied to the combined ingestion/dermal contact exposure scenario for lead applied to Future Child Residents. Hazard Indices greater than unity (> 1) would represent a cause for concern. With respect to lead, it has been reported that soil lead is not bioavailable below a concentration of 200 mg/kg. In light of the combined Hazard Index and lead bioavailability data, it has been determined that lead in site surface soils does not pose a significant health risk to Future Child Residents. The non-carcinogenic risk posed by zinc in soils was considerably lower (3.9×10^{-3}) than that posed by lead.

The remediation of surface and deep soils is not necessary to reduce the total risk from direct exposure (ingestion or dermal contact) to all site soil contaminants as the present levels are insignificant.

8.9.2 Soil Cleanup Levels for Groundwater Protection

USEPA's Center for Environmental Assessment Modelling (CEAM) provided their Exposure Assessment Multimedia Model (MultiMed) for application at the Collierville NPL site. The model was used in conjunction with traditional contaminant mass partitioning formulae to determine the soil cleanup goals necessary for protection of Memphis Sands aquifer quality.⁵ Based on site-specific soil and hydrogeologic conditions, a soil cleanup goal of 533 $\mu\text{g/kg}$ TCE was determined to be protective of the Memphis Sands aquifer. The goal is applicable to the contaminant source areas ('hot spots') previously discussed. Remedial efforts need only focus on a limited portion of the site as soil contaminants are restricted to approximately 20% of the total site area.

All discussions regarding MultiMed input variable selection, model outputs and soil cleanup goal calculations are provided in Appendix R.

8.9.3 Groundwater Cleanup Levels

The upper bound sum of cancer risks for current residents and future Site residents posed by the groundwater exposure pathway are 2.5×10^{-4} and 4.7×10^{-4} , respectively. These risk levels are significantly above the 10^{-6} point of departure but were calculated using highly conservative exposure assumptions. The Hazard Indices for lead and zinc are 3.2 and 0.87, respectively for current residents. These values indicate that lead may pose a significant non-carcinogenic risk (under the assumed current exposure conditions). The future resident hazard indices are 0.33,

⁵Contaminant partitioning equations from USEPA's *Determining Soil Response Action Levels Based on Potential Contaminant Migration to Groundwater: A compendium of Examples*, USEPA, OERR, EPA/540/2-89/057, October 1989.

4.1, and 0.82 for DCE, lead and zinc, respectively. Again, these values indicate that lead may pose a non-carcinogenic risk to future site residents obtaining potable water from the Memphis Sand aquifer.

As discussed earlier (Section 8.8), observed groundwater lead concentrations are not significantly elevated in comparison with background well concentrations (when comparing the 95 % upper confidence limit means of each population). As a result, the hazard indices computed for lead cannot be attributed to the site.

The 95 % upper confidence limit mean (over three sampling periods) from monitoring wells in the Memphis Sand aquifer were used to compute risk (or hazard indices) to future risk residents. The maximum concentration of each contaminant of concern identified in untreated Collierville municipal well system water was used to compute current resident risk (and hazard indices). 95 % upper confidence limit means were not computed for municipal well results due to a lack of sufficient degrees of freedom (1) for reasonable statistical assessment. This approach was taken based on USEPA recommendations and in accordance with USEPA, RAGS guidance on determining the reasonable maximum exposure (RME).

At the Collierville NPL site, these conservative assumptions are not a true representation of the existing or reasonable future exposure scenarios. Engineering controls (i.e. air stripping) are currently in place on municipal wells which supply potable water to the City of Collierville. The municipal wells are screened in the Memphis Sand aquifer which has been indirectly impacted by the Collierville site. Based on the conceptual site model developed in this report, there are two sets of groundwater cleanup goals. The first set were discussed in Section 8.9.2. Source area soil contaminant concentrations must be reduced to ensure that infiltrate passing through the source areas produces leachate of sufficient quality to prevent the degradation of the underlying Memphis Sands aquifer.

The second set of cleanup goals are the maximum contaminant limits (MCLs) as set forth by the Safe Drinking Water Act (Table 8-9). These represent the maximum concentrations of contaminants which may be present if a water source is to be used for potable purposes. The MCLs are currently met through the application of engineering controls. Administrative controls currently in place (i.e. permitting requirements) preclude the construction of potable water wells in the area without notice or permit. As a result, the potential for exposure to site related groundwater contaminants (at or near the concentrations used for risk computations) is not feasible under existing conditions.

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ATTACHMENT A

U. S. ENVIRONMENTAL PROTECTION AGENCY

EXPOSURE ASSESSMENT

MULTIMEDIA MODEL

MULTIMED (Version 1.01, June 1991)

Run options

CARRIER COLLIERVILLE

Chemical simulated is TCE

Option Chosen Saturated zone model
Run was MONTE
Infiltration input by user
Number of monte carlo simulations 200
Run was steady-state
Reject runs if Y coordinate outside plume
Do not reject runs if Z coordinate outside plume
Gaussian source used in saturated zone model

CHEMICAL SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS		LIMITS	
			MEAN	STD DEV	MIN	MAX
Solid phase decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Dissolved phase decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Overall chemical decay coefficient	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Acid catalyzed hydrolysis rate	l/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Neutral hydrolysis rate constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Base catalyzed hydrolysis rate	l/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Reference temperature	C	CONSTANT	25.0	-999.	0.000E+00	100.
Normalized distribution coefficient	ml/g	CONSTANT	0.126E+09	-999.	0.000E+00	-999.
Distribution coefficient	--	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Biodegradation coefficient (sat. zone)	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Air diffusion coefficient	cm ² /s	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
Reference temperature for air diffusion	C	CONSTANT	25.0	-999.	0.000E+00	100.
Molecular weight	g/M	CONSTANT	131.	-999.	0.000E+00	-999.
Mole fraction of solute	--	CONSTANT	0.123E-05	-999.	0.100E-08	1.00
Vapor pressure of solute	mm Hg	CONSTANT	74.0	-999.	0.000E+00	100.
Henry's law constant	atm-m ³ /M	CONSTANT	0.110E-01	-999.	0.100E-09	1.00
Overall 1st order decay sat. zone	1/yr	DERIVED	0.000E+00	0.000E+00	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00

SOURCE SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS		LIMITS	
			MEAN	STD DEV	MIN	MAX
Infiltration rate	m/yr	UNIFORM	0.450	-999.	0.157	0.450
Area of waste disposal unit	m ²	CONSTANT	0.200E+05	-999.	0.100E-01	-999.
Duration of pulse	yr	CONSTANT	-999.	-999.	0.100E-08	-999.
Spread of contaminant source	m	DERIVED	33.3	-999.	0.100E-08	0.100E+11
Recharge rate	m/yr	CONSTANT	0.000E+00	-999.	0.000E+00	0.100E+11
Source decay constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Initial concentration at landfill	mg/l	NORMAL	0.330E-01	0.760E-01	0.500E-02	0.240
Length scale of facility	m	DERIVED	200.	-999.	0.100E-08	0.100E+11
Width scale of facility	m	DERIVED	200.	-999.	0.100E-08	0.100E+11
Near field dilution		DERIVED	1.00	0.000E+00	0.000E+00	1.00

AQUIFER SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS		LIMITS	
			MEAN	STD DEV	MIN	MAX
Particle diameter	cm	CONSTANT	0.500E-01	-999.	0.100E-08	100.
Aquifer porosity	--	CONSTANT	0.350	-999.	0.100E-08	0.990
Bulk density	g/cc	CONSTANT	1.86	-999.	0.100E-01	5.00
Aquifer thickness	m	CONSTANT	1.00	-999.	0.100E-08	0.100E+06
Source thickness (mixing zone depth)	m	CONSTANT	1.00	-999.	0.100E-08	0.100E+06
Conductivity (hydraulic)	m/yr	UNIFORM	0.320E+04	-999.	320.	0.320E+05
Gradient (hydraulic)		UNIFORM	0.300E-01	-999.	0.300	0.500
Groundwater seepage velocity	m/yr	DERIVED	-999.	-999.	0.100E-09	0.100E+09
Retardation coefficient	--	DERIVED	-999.	-999.	1.00	0.100E+09
Longitudinal dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Transverse dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.
Vertical dispersivity	m	FUNCTION OF X	1.00	-999.	-999.	-999.
Temperature of aquifer	C	CONSTANT	17.0	-999.	0.000E+00	100.
pH	--	CONSTANT	5.50	-999.	0.300	14.0
Organic carbon content (fraction)		CONSTANT	0.130E-02	-999.	0.100E-05	1.00
Well distance from site	m	CONSTANT	100.	-999.	1.00	-999.
Angle off center	degree	CONSTANT	0.000E+00	-999.	0.000E+00	360.
Well vertical distance	m	CONSTANT	0.000E+00	-999.	0.000E+00	1.00

0 Values generated which exceeded the specified bounds.

----- RESULTS -----

SATURATED ZONE TRANSPORT
CARRIER COLLIERVILLE - LEE THOMAS RESPONSE RUN

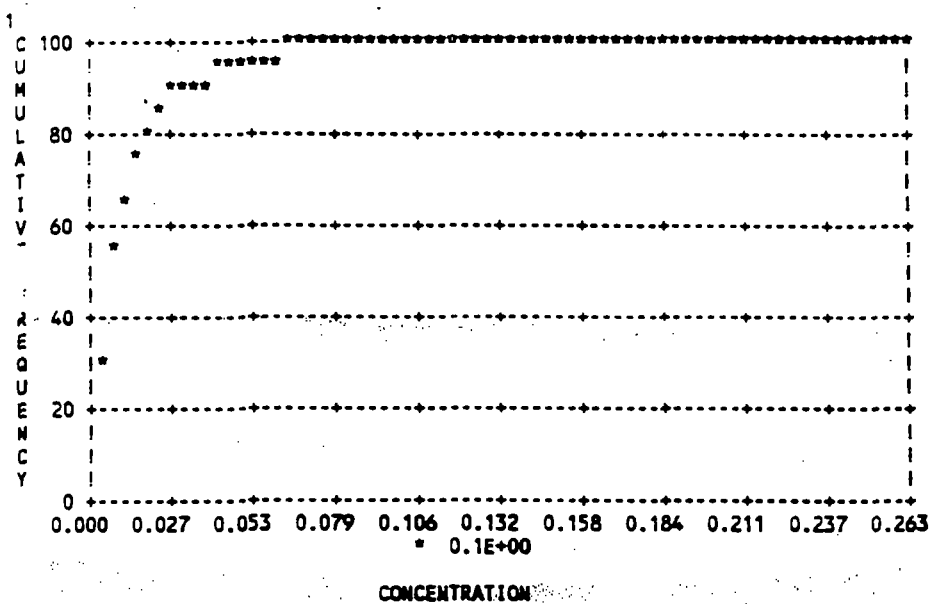
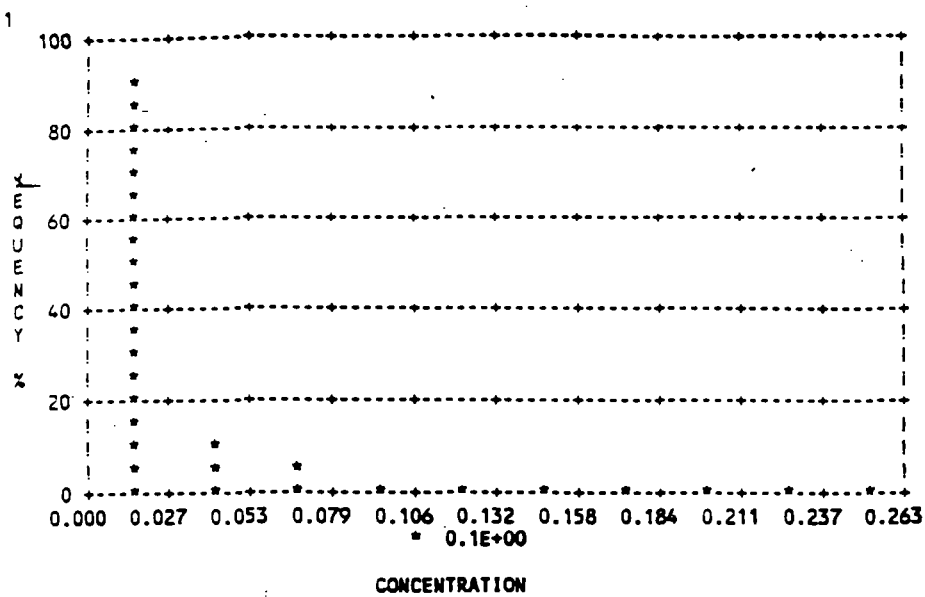
CASE

95. PERCENT CONFIDENCE INTERVAL

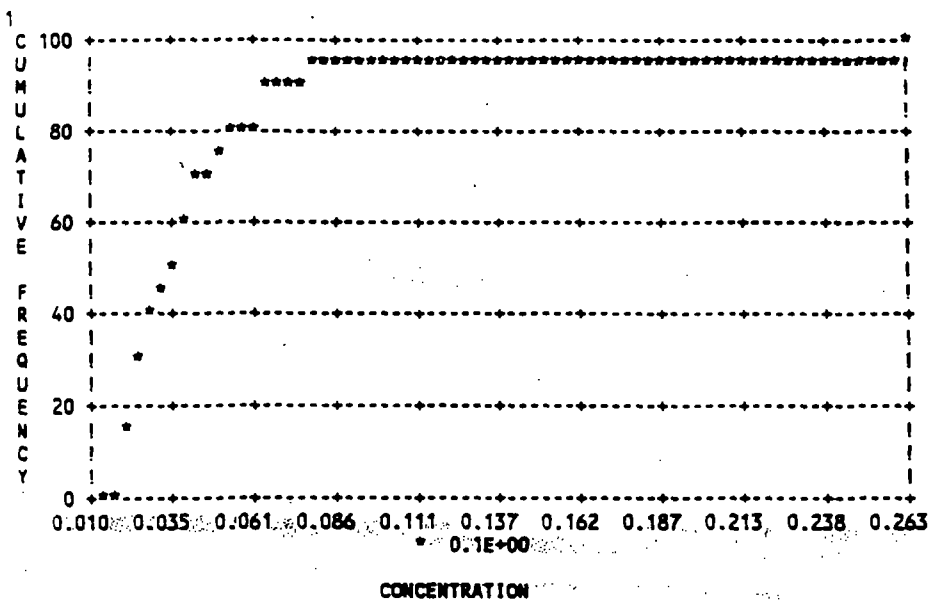
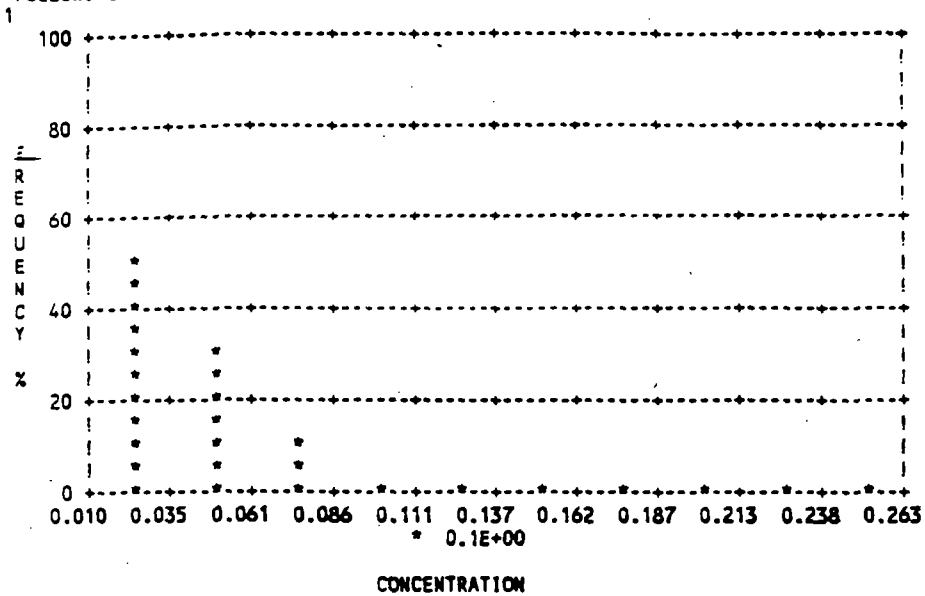
N	=	200		
MEAN	=	0.141E-02		
STANDARD DEVIATION	=	0.245E-02		
COEFFICIENT OF VARIATION	=	1.74		
MINIMUM VALUE	=	0.444E-04		
MAXIMUM VALUE	=	0.263E-01		
50th PERCENTILE	=	0.685E-03	0.603E-03	0.790E-03
80th PERCENTILE	=	0.181E-02	0.143E-02	0.241E-02
85th PERCENTILE	=	0.225E-02	0.181E-02	0.318E-02
90th PERCENTILE	=	0.337E-02	0.241E-02	0.429E-02
95th PERCENTILE	=	0.502E-02	0.385E-02	0.737E-02

-999 UNABLE TO COMPUTE CONFIDENCE BOUND DUE TO INSUFFICIENT DATA

VALUE	% OF TIME EQUALLED OR EXCEEDED	% OF TIME IN INTERVAL
0.444E-04	100.000	88.000
0.267E-02	12.000	8.000
0.530E-02	4.000	3.000
0.793E-02	1.000	0.000
0.106E-01	1.000	0.000
0.132E-01	1.000	0.000
0.158E-01	0.500	0.000
0.184E-01	0.500	0.000
0.211E-01	0.500	0.000
0.237E-01	0.500	0.000
0.263E-01	0.500	0.000



FOLLOWING GRAPHS ARE FOR THE TOP 20% OF THE RESULTS



ATTACHMENT B

CARRIER SHALLOW GROUNDWATER DATA
URCE ZONE WELLS)

TA SUMMARY

MW#	CONC (PPB)	MW#	CONC (PPB)	MW#	CONC (PPB)	MW#	CONC (PPB)	MW	CONC (PPB)	MW	CONC (PPB)	MW#	CONC (PPB)	MW#	CONC (PPB)
1B	220	3	2400	5	260	9	20	15	38000	29	0	31	288	35	0
	390		3400		1200		30		150000		0		55		0
	380		2500		1900				120000						
	305		1800		4800				59000						
	300		4100		3200				940						
	330		1600		3100				19000						
	620		2800		2200				55000						
	490		5200		9000				20000						
	790		3300		4500				120000						
	820		3100		6500				5900						
	340		2500		8200				64000						
	500		8000		4200				140000						
	420		2600		4700										
	760		1300		1500										
	440		5400		760										
	440		2900		7500										
	77		5000		4600										
	130		6000		5600										
	310		6200		11000										
	320		7800		4400										
	490		5000		7300										
	940														
	1100														
	580														
	760														
	850														

AVERAGED DATA SUMMARY

MW#	CONC (PPB)
1B	504
3	3948
5	4591
9	25
15	65987
29	0
31	172
35	0

$$9403 = 9.4 \text{ PPM}$$

FLUSHING COEFFICIENT CALCULATION SUMMARY

fil: MULTITAR.WQ1

KNOWN DATA		ENTER VALUE !!!!	UNITS
Xlch	= INITIAL LEACHATE CONCENTRATION	9.40E+00	mg/l
Xsoil(init)	= INITIAL SOIL CONCENTRATION	1.52E+02	mg/kg
Vperc'	= PERCOLATE VOLUME PER YEAR	1.45E+05	ft^3/yr
Kvad	= VERTICAL HYDRAULIC CONDUCTIVITY	3.30E+00	ft/yr
Dvad	= THICKNESS OF VADOSE ZONE	5.00E+01	ft
Vsoil	= VADOSE ZONE SOIL VOLUME	6.53E+07	ft^3
Ch2o	= WATER MASS BALANCE COEFFICIENT	2.92E-01	DIMENSIONLESS
n	= POROSITY OF VADOSE ZONE	3.50E-01	DIMENSIONLESS
g	= SPECIFIC WEIGHT OF SOIL	2.65E+00	g/ml
CALCULATED RESULTS			
Vperc'	= PERCOLATE VOLUME PER YEAR	4.11E+06	l/yr
Tperc	= PERCOLATE RETENTION TIME	1.52E+01	yr
Vperc	= PERCOLATE RETENTION VOLUME	6.22E+07	l
Vsoil	= VADOSE ZONE SOIL VOLUME	1.85E+09	l
Mconperc	= MASS OF CONTAMINANT IN PERCOLATE	5.85E+08	mg
Mconsoil	= MASS OF CONTAMINANT IN SOIL	4.85E+11	mg
Msoil	= MASS OF SOIL IN VADOSE ZONE	3.19E+09	kg
Fcal	= CALCULATED FLUSHING COEFFICIENT	4.14E-03	DIMENSIONLESS
INDEX OF FORMULAS			

$$T_{perc} = \frac{D_{vad}}{K_{vad}}$$

$$F_{cal} = \frac{M_{conperc}}{Ch2o * M_{consoil}}$$

$$V_{perc} = T_{perc} * V_{perc}'$$

$$M_{soil} = V_{soil} * g * (1 - n)$$

$$M_{conperc} = X_{lch} * V_{perc}$$

$$M_{consoil} = M_{soil} * X_{soil}$$

NOTE: * INITIAL LEACHATE CONC. F/AUGUST, 1991, GW ANALYTICAL DATA FOR WELLS SCREENED NEAR THE JACKSON CLAY SURFACE WITHIN THE SOURCE ZONE.
 * EXISTING SOIL CONCENTRATION (MEAN) FROM TABLE 8-6, REMEDIAL INVESTIGATION, JUNE, 1991

— TARGET LEVELS FOR SOIL CLEAN-UP

fil: MULTITAR.WQ1

KNOWN DATA		ENTER VALUE !!!!	UNITS
Xleh	= ALLOWABLE LEACHATE CONCENTRATION	3.30E-02	mg/L
Vperc'	= PERCOLATE VOLUME PER YEAR	1.45E+05	ft^3/yr
Kvad	= VERTICAL HYDRAULIC CONDUCTIVITY	3.30E+00	ft/yr
Dvad	= THICKNESS OF VADOSE ZONE	5.00E+01	ft
Vsoil	= VADOSE ZONE SOIL VOLUME	6.53E+07	ft^3
Ch2o	= WATER MASS BALANCE COEFFICIENT	2.92E-01	DIMENSIONLESS
Fcal	= CALCULATED FLUSHING COEFFICIENT	4.14E-03	DIMENSIONLESS
n	= POROSITY OF VADOSE ZONE	3.50E-01	DIMENSIONLESS
g	= SPECIFIC WEIGHT OF SOIL	2.65E+00	g/ml

CALCULATED RESULTS

Vperc'	= PERCOLATE VOLUME PER YEAR	4.11E+06	L/yr
Vsoil	= VADOSE ZONE SOIL VOLUME	1.85E+09	L
Tperc	= PERCOLATE RETENTION TIME	1.52E+01	yr
Vperc	= PERCOLATE RETENTION VOLUME	6.22E+07	L
Mconperc	= MASS OF CONTAMINANT IN PERCOLATE	2.05E+06	mg
Mconsoil	= MASS OF CONTAMINANT IN SOIL	1.70E+09	mg
Msoil	= MASS OF SOIL IN VADOSE ZONE	3.19E+09	kg
Xsoil	= TARGET LEVEL FOR SOIL CLEAN-UP	5.33E-01	mg/kg
	= TARGET LEVEL FOR SOIL CLEAN-UP	533	ppb

INDEX OF FORMULAS

Tperc	=	$\frac{Dvad}{Kvad}$	Mconsoil	=	$\frac{Mconperc}{Ch2o * Fdgn}$
Vperc	=	Tperc * Vperc'	Msoil	=	Vsoil * g * (1 - n)
Mconperc	=	Xleh * Vperc	Xsoil	=	$\frac{Mconsoil (mg)}{Msoil (kg)}$

ATTACHMENT C

Memphis Sands Aquifer Characteristics

Transmissivity (gpd/ft)	= 242,500
Storage Coefficient	= 0.001 to 0.0001
Vertical Hydraulic Conductivity of Jackson Clay Aquitard	= 0.03-0.62 gpm
Horizontal Hydraulic Conductivity of Memphis Sands Aquifer	= 1,212.5 gpd/ft

Contaminant Distribution (Mass Partitioning)

In Vadose Zone Soils

In order to determine the distribution of contaminants in the soil medium, formulae were obtained from USEPA's Determining Soil Response Action Levels Based on Potential Contaminant Migration to Ground Water: A Compendium of Examples, Document Number EPA/540/2-89/057, October 1989. The required calculations are as follows:

$$C_t = (\gamma_s * C_s) + (\theta * C_l) + (a * C_g)$$

Where: C_t	= Total Contaminant Fraction	= 1.0
γ_s	= Bulk Density of Soil (g/cm ³)	= 2.65 * (1 - porosity)
C_s	= Solid Phase Contaminant Constant	
θ	= Moisture Content of Soil (volume fraction)	= 0.15
C_l	= Liquid Phase Contaminant Constant	
a	= Air Content of Soil (volume fraction)	= 0.15
C_g	= Gas Phase Contaminant Constant	

$$C_s = K_H * C_l$$

$$C_g = K_a * C_l$$

Where:	K_H	= Assumed @ 0.4 (from Stamina Mills RI for TCE.)	
	K_a	= Normalized Distribution Coefficient	= $K_{ow} * TOC$
	K_{ow}	= Distribution Coefficient for Trichloroethylene	
	TOC	= Total Organic Carbon Fraction	= 0.0013

Contaminant Distribution Calculations (Mass Partitioning)

Vapor Partitioning Coefficient (C_{vapor}):

$$\begin{aligned}a * C_g / C_l &= a * K_H / [\gamma_s * K_d + \theta + a * K_H] \\&= (0.15)(0.4) / [1.85(0.164) + 0.15 + (0.15)(0.4)] \\&= (0.06) / [0.303 + 0.15 + 0.06] \\&= 0.117\end{aligned}$$

Solid Partitioning Coefficient (C_{solid}):

$$\begin{aligned}b * C_s / C_l &= \gamma_s * K_d / [\gamma_s * K_d + \theta + a * K_H] \\&= (1.85)(0.164) / [(1.85)(0.164) + 0.15 + (0.15)(0.4)] \\&= (0.303) / [0.303 + 0.15 + 0.06] \\&= 0.591\end{aligned}$$

Water Partitioning Coefficient ($C_{\text{H}_2\text{O}}$):

$$\begin{aligned}c * C_l / C_l &= 1 - (0.117 + 0.591) \\&= 0.292\end{aligned}$$

Note: Calculations assume 30% bulk soil porosity in Terrace Deposits; 70% solids; 50% interstitial saturation.

From these calculations, it can be determined that nearly 30% of soil TCE is present in the soil-bound water phase. This information is useful as contaminant transport in soils (at or near saturation) is dependent upon the movement of contaminants in the aqueous phase. Therefore, the determination of the portion of contaminant present in soil moisture facilitates the calculation of contaminant flushing efficiency, and in turn, the rate of contaminant transfer to other media (i.e. groundwater).

Thornthwaite Equation

The Thornthwaite equation may be used to calculate PET on the basis of average monthly temperature as follows:

$$i = (T/5)^{1.514} = \text{monthly heat index}$$

$$I = \sum i = \text{heat index}$$

$$a = 0.49 + (0.0179 * I) - (0.0000771 * I^2) + (0.000000675 * I^3)$$

$$E_p = 1.6 [(10 * T_p) / I]^a$$

$$E_p = \text{Potential Evapotranspiration (PET)}$$

$$T_p = \text{Temperature } ^\circ\text{C}$$

Note: The Thornthwaite Equation is generally conservative in that it yields under estimated values for PET.

Thornthwaite Applications

$$\begin{aligned} I &= 1.185 + 1.551 + 3.219 + 6.049 + 8.917 + 11.926 + 13.04 + 12.688 + \\ &\quad 10.189 + 6.548 + 1.837 + 1.448 \\ &= 78.60 \end{aligned}$$

$$\begin{aligned} a &= 0.49 + 1.407 - 0.476 + 0.328 \\ &= 1.749 \end{aligned}$$

The average monthly temperature values used to compute monthly heat indexes (i) were obtained from the Shelby County Soil Survey. Using this temperature data, PET for each month of the was computed and is summarized below in Table 1.

TABLE 1 MONTHLY PET VALUES												
	J	F	M	A	M	J	J	A	S	O	N	D
E_t cm	0.9	1.2	2.8	5.9	9.3	13.1	14.5	14.0	10.9	6.5	1.5	1.1
E_t mm	8.8	12.1	28.3	59.1	93.0	131	145	140	109	64.9	14.7	11

These PET values may be used in conjunction with precipitation and soil data to compute annual an percolate volume. This is accomplished through application of the water balance method. The water balance for the Collierville NPL Site is shown in Table 2.

Water Balance Assumptions

Cr/o	=	Coefficient of Runoff	=	0.45
ST	=	Soil Moisture Storage	=	150 mm available water based on loamy silt surface soils. Residual moisture (May through October) obtained from tabulated values)
AET	=	Actual Evapotranspiration	=	PET if AST is positive or 0
	=		=	PET + [(I - PET) - AST] if AST is negative.
PERC	=	Percolation Rate	=	I - AET if ST = 150 mm
	=		=	I - AET - AST during soil recharge (November through January)

TABLE 2
COLLIERVILLE NPL SITE
WATER BALANCE TABLE

Parameter	J	F	M	A	M	J	J	A	S	O	N	D	
PET mm/mo.	9	12	28	59	93	131	145	140	109	65	15	11	
P ^A mm/mo.	154	119	129	118	107	93	80	75	72	69	111	125	
C _{RO}	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	
R/O mm/mo.	69	54	58	53	48	42	41	34	32	31	50	56	
I P-R/O	85	65	71	65	59	51	50	41	40	38	61	69	
I-PET	+76	+53	+43	+6	-34	-80	-95	-99	-69	-27	+46	+58	
ΣNEG 1-PET				(0)	-34	-114	-209	-308	-377	-404			
ST mm	150	150	150	150	119	69	36	18	12	10	56	114	
Δ ST	+36	0	0	0	-31	-50	-33	-18	-6	-2	+46	+58	
AET mm/mo.	9	12	28	59	90	101	83	59	46	40	15	11	
PERC. mm/mo.	40	53	43	6	0	0	0	0	0	0	0	0	142 mm/yr

Notes:

PET = Potential Evapotranspiration
P = Precipitation
C_{RO} = Coefficient of Runoff
R/O = Runoff
(From Thornthwaite Equation)

I = Infiltration
ST = Soil Moisture Storage for Loamy Soil (150 mm available H₂O)
AET = Actual Evapotranspiration
PERC = Percolate

^A - from USDA/SCS Shelby County Soil Survey - Precipitation Records 1931-1980

9.0 CONCLUSIONS

The objectives of the Remedial Investigation Work Plan for the Collierville Site were:

- To characterize site contaminants,
- To determine the nature and extent of contamination,
- To more fully characterize the geology/hydrogeology of the Site, and
- To recommend feasible remedial alternatives.

The principal contaminants of concern established for the investigation were established as trichloroethylene (TCE) and its degradation products. The investigation identified the nature and extent of contamination in soils and groundwater. The Site geology/hydrogeology was more fully characterized and fate and transport mechanisms for contaminants in groundwater were identified. A treatability study has been implemented to evaluate an in-situ soil gas and groundwater extraction system. Final remedial alternatives will be evaluated in the Feasibility Study (FS). All of the outlined objectives have been achieved; therefore, no further remedial investigation activities are deemed necessary at the Collierville Site.

APPENDIX A

DATA QUALIFIER EXPLANATIONS

A.1 Explanation of Organic Analysis Table Notes

U Notation - Compound Was Not Detected

The U notation is always presented in conjunction with the instrument or method detection limit value; and indicates that the compound was analyzed for but not detected above the stated detection limit.

B Notation - Compound was detected in the Laboratory Blank

A "B" notation in data tables indicates that the compound was found in laboratory or field blanks, as well as in the sample. The compounds therefore may have been introduced into the sample during sample collection or preparation and cannot be verified to be present in the sample.

J Notation - Compound was detected at a concentration below the quantitation limit

The "J" notation data tables indicates that compounds were detected at a concentration below the quantitation limit, and that the concentration reported is subject to significant error. Values accompanied by a J notation should, therefore, be considered qualitative.

To understand the error in "J-values" reported at levels below the quantitation limit, it must be recognized that all instrumental methods used to determine chemical concentrations in a sample, including the gas chromatography/mass spectrometry (GC/MS) method used for analysis of volatile and semi-volatile TCL compounds at this site, rely on being able to relate a signal from the instrument to concentration. For most instrumental methods and chemical concentration, this relationship is linear; however, at very low concentrations, the relationship tends to deviate from linearity due to background interference in the sample and to instrumental limitations. As quantitation limits differ for different methods and between samples, before beginning any analysis, the point at which linearity is deviated from, or the lowest concentration that can be accurately be measured, must be determined. This lower limit is called the "quantitation limit". Although the presence and identity of a compound might be determined below this quantitation limit, estimates of concentrations below the limit are suspect and may contain very large errors. The meaning and implications of quantitation limits in chemical analyses have received considerable attention in the literature (Long and Winefordner, 1983; Porter et al. 1988) but is often treated too casually when interpreting environmental data.

Because contract laboratories, are only required to validate the accuracy of their analysis to the quantitation limit, significant error may be associated with estimating concentrations below the quantitation limit determined by the laboratory. Hence it is inappropriate to consider the concentrations of J noted values as anything but estimates.

C Notation - Confirmation Test was performed

The C Notation in pesticide analyses indicates that a single component pesticide has been confirmed by GC/MS analysis after being indicated in a GC procedure. Positive GC pesticide values that are not confirmed should not be reported.

D Notation - Secondary dilution factor used

The D notation identifies compounds that were analyzed using a secondary dilution factor.

E Notation - Concentration exceeds the linear range of the instrument

The "E" notation in data tables indicates that these compounds were detected at a concentration that exceeded the linear range (or upper quantitation limit) of the instrument, and that the concentration reported is subject to error. The concentration of "E" noted compounds should, therefore, be considered qualitative.

Analogous to the deviation from linearity of instrument response to compound concentration at very low concentrations, instrument response may deviate from linearity, that is become less accurate, at elevated concentrations. Factors producing a lower limit to accurate measurement were identified in the discussion of J notation above. Factors producing this upper limit include the total number and concentration of natural and anthropogenic compounds in the sample, as well as the concentration of the specific compound being measured. Analyses of compounds in solids, such as soil or waste,

are more likely to exceed this upper limit than aqueous samples, as most organic compounds (natural and anthropogenic) in the environment have a higher affinity for soil matrices than for water.

Also analogous to lower limits of quantitation, before beginning any analysis, the upper limit at which linearity is deviated from, or the highest concentration that can accurately be measured, must be determined. Estimates of concentrations above this limit are suspect and may contain very large errors. Because contract laboratories only validate the accuracy of their analysis to some upper limit, significant error may be associated with estimating concentrations above the upper limit determined by the laboratory.

X Notation - Compound Coeluted with one or more other compounds

GC/MS is the most powerful commercially available analytical method of separating, identifying and quantifying a large number of compounds that may be present in an environmental sample. Nevertheless, in some instances, two compounds can not be completely separated from each other, the concentrations of coeluting compounds should be considered only estimates.

Note 1 - More than one method was used to analyze this sample

Note 1 identifies several samples that were analyzed by more than one method. This does not diminish the quality of data collected, but rather produces more information than would be generated by a single analysis. The reason for performing two analyses of some samples is discussed.

As previously described for notes J and E, instrumental methods of measuring compound concentration have both a lower limit and an upper limit to accurate measurement. Although the lower limit to quantitation can not be significantly lowered, the chemist may use a number of different sample preparation techniques to extend the upper limit of quantitation. To select a sample preparation technique appropriate for analyzing a given sample, the chemist must first estimate the relative number and concentration of compounds in the sample. For the analysis of volatile compound, the CLP Statement of Work recommends that to do this the chemist use either professional judgment, or an instrumental screening method. If the chemist determines that the number and concentration of compounds in a sample is likely to be low, the CLP Statement of Work recommends a "low soil/sediment" method which involves bubbling an inert gas through a mixture of solid sample and water to remove volatile compounds. If the chemist determines that the number and concentration of compounds in a sample is likely to be moderate, the CLP Statement of Work recommends a "medium soil/sediment" method, which involves extracting the sample with methanol, diluting the methanol with water, then bubbling a gas through the methanol/water mixture to remove the compounds. An

analogous choice between using a low versus a medium soil/sediment method is made before analyzing a sample for semi-volatile compounds.

To analyze a soil sample potentially containing compounds over a wide range of concentrations, the chemist may choose to analyze the sample twice -- once using a low, and once a medium soil/sediment method. The use of two methods to analyze a sample increases the amount of information that can be gained from that sample. For compounds that can be quantified accurately by both methods, however, the two methods of analysis may produce different results. This is primarily the result of using different extraction techniques and holding times, but may also be due in part to the use of different sample size, the efficiency of sample mixing and sample handling.

Note that in some cases, a chemist may choose a single soil/sediment method, then reanalyze the sample after dilution in order to quantitate both compounds present in very low and moderate concentrations. Similarly, dilution may be employed to analyze a wide range of compound concentrations in groundwater samples where only one method of analysis is recommended by the CLP Statement of Work. As only one extraction method is employed for diluted samples, significantly different results were not produced for compounds that could be analyzed in two different dilutions of a sample. For consistency, however, if compounds could be quantified at concentrations not exceeding the upper limit to quantitation in undiluted sample preparations, concentrations from

these analyses are reported in Table 2; otherwise, diluted sample results are reported.

A.2 Explanation of Inorganic TAL Table Notes

U Notation - Compound Was Not Detected

The U notation is always presented in conjunction with the instrument or method detection limit value; and indicates that the element was analyzed for but not detected above the stated detection limit.

B Notation - Compound was detected in the laboratory blank

As noted above the TCL analyses "B" notation indicates that the compound was also found in laboratory or field blanks and therefore may have been introduced into the sample during sample collection or preparation. Compounds marked with a "B" may be present in the field at much lower concentrations or not at all.

*** Notation - Deviation between duplicate analyses was greater than CLP guidelines**

The "*" notation indicates the difference in concentrations obtained from duplicate analyses of these compounds were slightly greater than CLP Statement of Work guidelines.

W Notation - Recovery in spiked samples fell below CLP guidelines

The "W" notation differs from the N notation only in indicating at what point in the analytical procedure the test of accuracy, spiking failed. The "W" notation indicates that the recovery of an analyte in spiked water samples fell below CLP Statement of Work guidelines.

METHOD NOTATIONS:

P - Indicates ICP analysis

F - Indicates AA furnace analysis

CV - Indicates AA cold vapor analysis

AS - Indicates Technicon analysis

APPENDIX B

COLLIERVILLE SITE REMEDIAL INVESTIGATION

PHASE 1 SAMPLING ANALYTICAL RESULTS SUMMARY

SOIL DATA

QUALITY ASSURANCE FLAG LEGEND

- B = ANALYTE FOUND IN BLANK
- BDL = ANALYZED FOR BUT NOT FOUND AT DETECTION LIMIT (SEE ALSO U)
- CV AA (COLD VAPOR) METHOD OF ANALYSIS FOR METALS
- D = COMPOUND ANALYZED FROM A DILUTED SAMPLE
- E = ORGANIC COMPOUNDS: CONCENTRATION EXCEEDS CALIBRATION RANGE
METALS: VALUE ESTIMATED DUE TO INTERFERENCES
- F = AA (FURNACE) METHOD OF ANALYSIS FOR METALS
- J = VALUE ESTIMATED
- N = SPIKE SAMPLE RECOVERY OUTSIDE OF CONTROL LIMITS
- P = ICAP METHOD OF ANALYSIS FOR METALS
- S = VALUE DETERMINED BY METHOD OF STANDARD ADDITIONS
- U = ANALYZED FOR BUT NOT DETECTED
- W = POST DIGESTION AA SPIKE OUTSIDE OF CONTROL LIMITS, AND SAMPLE
ABSORBANCE LESS THAN 50% OF SPIKE ABSORBANCE
- * = DEVIATION BETWEEN DUPLICATE INORGANIC ANALYSES GREATER THAN
CLP SOW GUIDELINES
- + = STANDARD ADDITIONS CORRELATION COEFFICIENT LESS THAN 0.995

				Boring 37							
LAB SAMPLE ID				B37-1		B37-2		B37-3		B37-4	
SAMPLING DATE				01/17/90		01/17/90		01/17/90		01/17/90	
DEPTH				8		18		24		32	
MATRDC				SOIL		SOIL		SOIL		SOIL	
CMP	CL	COMPOUND	UNITS	mg/kg		mg/kg		mg/kg		mg/kg	
101	M	Antimony		BDL	5000	BDL	4500	BDL	4400	BDL	4400
102	M	Arsenic		4100	F S N	920	B F N	2400	F N	870	B F N
103	M	Beryllium		790	B P	470	B P	240	B P	270	B P
104	M	Cadmium		BDL	1200	BDL	1100	BDL	1100	BDL	1000
105	M	Chromium		23200	P *	12500	P *	23400	P *	18700	P *
106	M	Copper		9700	P	6100	P	5800	P	3300	B P
107	M	Lead		11000	F S N	4500	F N	2200	F N	1700	F N
108	M	Mercury		BDL	120	BDL	110	BDL	110	BDL	100
109	M	Nickel		9500	P *	BDL	6200	BDL	6100	BDL	6000
110	M	Selenium		BDL	2300	BDL	2200	BDL	2100	BDL	420
111	M	Silver		BDL	940	BDL	880	BDL	840	BDL	830
112	M	Thallium		BDL	480	BDL	430	BDL	420	BDL	420
113	M	Zinc		20200	P	11300	P	15300	P	11800	P
114	M	Barium		53800	P	20300	B P	30100	B P	6200	B P
115	M	Iron		2E+07	P *	7E+06	P *	1E+07	P *	9E+06	P *
116	M	Manganese		133000	P *	29000	P *	338000	P *	41400	P *
117	M	Vanadium		38200	P	18800	P	20300	P	12700	P
118	M	Aluminum		2E+07	P	1E+07	P	4E+06	P	3E+06	P
120	M	Cobalt		7800	B P *	4000	B P *	10200	B P *	2500	B P *
121	M	Magnesium		1E+06	P	570000	B P	171000	B P	97200	B P
129	M	Calcium		1E+06	B P	490000	B P	154000	B P	101000	B P
130	M	Sodium		BDL	351000	BDL	321000	BDL	314000	BDL	311000
131	M	Potassium		929000	B P	891000	B P	265000	B P	BDL	263000
UNITS				ug/kg		ug/kg		ug/kg		ug/kg	
203	V	Benzene		BDL	5	BDL	5	BDL	5	BDL	5
205	V	Bromoforn		BDL	5	BDL	5	BDL	5	BDL	5
206	V	Carbon tetrachloride		BDL	5	BDL	5	BDL	5	BDL	5
207	V	Chlorobenzene		BDL	5	BDL	5	BDL	5	BDL	5
208	V	Dibromochloromethane		BDL	5	BDL	5	BDL	5	BDL	5
209	V	Chloroethane		BDL	12	BDL	11	BDL	11	BDL	10
211	V	Chloroform		BDL	5	BDL	5	BDL	5	BDL	5
212	V	Bromodichloromethane		BDL	5	BDL	5	BDL	5	BDL	5
214	V	1,1-Dichloroethane		BDL	5	BDL	5	BDL	5	BDL	5
215	V	1,2-Dichloroethane		BDL	5	BDL	5	BDL	5	BDL	5
216	V	1,1-Dichloroethane		BDL	5	BDL	5	BDL	5	BDL	5
217	V	1,2-Dichloropropane		BDL	5	BDL	5	BDL	5	BDL	5
218	V	Chloro-1,2-Dichloropropane		BDL	5	BDL	5	BDL	5	BDL	5
219	V	Ethylbenzene		BDL	5	BDL	5	BDL	5	BDL	5
220	V	Bromomethane		BDL	12	BDL	11	BDL	11	BDL	10
221	V	Chloromethane		BDL	12	BDL	11	BDL	11	BDL	10
222	V	Methylene chloride		9 B		19 B		7 B		20 B	
223	V	1,1,2,2-Tetrachloroethane		BDL	5	BDL	5	BDL	5	BDL	5
224	V	Tetrachloroethene		BDL	5	BDL	5	BDL	5	BDL	5
225	V	Toluene		BDL	5	BDL	5	BDL	5	BDL	5
227	V	1,1,1-Trichloroethane		BDL	5	BDL	5	BDL	5	BDL	5
228	V	1,1,2-Trichloroethane		BDL	5	BDL	5	BDL	5	BDL	5
229	V	Trichloroethene		BDL	5	BDL	5	BDL	5	BDL	5
231	V	Vinyl chloride		BDL	12	BDL	11	BDL	11	BDL	10
230	V	Trans-1,2-Dichloropropene		BDL	5	BDL	5	BDL	5	BDL	5
231	V	Styrene		BDL	5	BDL	5	BDL	5	BDL	5
232	V	Acetone		18 B		15 B		16 B		26 B	
233	V	2-Butanone		BDL	12	BDL	11	BDL	11	BDL	10
234	V	Carbon disulfide		BDL	5	BDL	5	BDL	5	BDL	5
235	V	2-Hexanone		BDL	12	BDL	11	BDL	11	BDL	10
236	V	4-Methyl-2-pentanone		BDL	12	BDL	11	BDL	11	BDL	10
237	V	Vinyl acetate		BDL	12	BDL	11	BDL	11	BDL	10
238	V	Xylenes (Total)		BDL	5	BDL	5	BDL	5	BDL	5
239	V	1,2-Dichloroethane (Total)		BDL	5	BDL	5	BDL	5	BDL	5

Revision: November 21, 1991

			Boring 37							
LAB SAMPLE ID			B37-1		B37-2		B37-3		B37-4	
SAMPLING DATE			01/17/90		01/17/90		01/17/90		01/17/90	
DEPTH			8		18		24		32	
MATRIX			SOIL		SOIL		SOIL		SOIL	
UNITS			mg/kg		mg/kg		mg/kg		mg/kg	
UNITS			ug/kg		ug/kg		ug/kg		ug/kg	
401	B	Acenaphthene	BDL	390	BDL	380	BDL	350	BDL	340
402	B	Acenaphthylene	BDL	390	BDL	380	BDL	350	BDL	340
403	B	Anthracene	BDL	390	BDL	380	BDL	350	BDL	340
405	B	Benzo(a)anthracene	BDL	390	BDL	380	BDL	350	BDL	340
406	B	Benzo(a)pyrene	BDL	390	BDL	380	BDL	350	BDL	340
407	B	Benzo(b)fluoranthene	BDL	390	BDL	380	BDL	350	BDL	340
408	B	Benzo(g,h,i)perylene	BDL	390	BDL	380	BDL	350	BDL	340
409	B	Benzo(k)fluoranthene	BDL	390	BDL	380	BDL	350	BDL	340
410	B	bis(2-Chloroethoxy)methane	BDL	390	BDL	380	BDL	350	BDL	340
411	B	bis(2-Chloroethyl)ether	BDL	390	BDL	380	BDL	350	BDL	340
412	B	bis(2-Chloroisopropyl)ether	BDL	390	BDL	380	BDL	350	BDL	340
413	B	bis(2-Ethylhexyl)phthalate	200 J		62 J		100 J		35 J	
414	B	4-Bromophenyl phenyl ether	BDL	390	BDL	380	BDL	350	BDL	340
415	B	Butyl benzyl phthalate	BDL	390	BDL	380	BDL	350	BDL	340
416	B	2-Chloronaphthalene	BDL	390	BDL	380	BDL	350	BDL	340
417	B	4-Chlorophenyl phenyl ether	BDL	390	BDL	380	BDL	350	BDL	340
418	B	Chrysene	BDL	390	BDL	380	BDL	350	BDL	340
419	B	Dibenzo(a,h)anthracene	BDL	390	BDL	380	BDL	350	BDL	340
420	B	1,2-Dichlorobenzene	BDL	390	BDL	380	BDL	350	BDL	340
421	B	1,3-Dichlorobenzene	BDL	390	BDL	380	BDL	350	BDL	340
422	B	1,4-Dichlorobenzene	BDL	390	BDL	380	BDL	350	BDL	340
423	B	3,3'-Dichlorobenzidine	BDL	780	BDL	720	BDL	700	BDL	680
424	B	Diethyl phthalate	BDL	390	BDL	380	BDL	350	BDL	340
425	B	Dimethyl phthalate	BDL	390	BDL	380	BDL	350	BDL	340
426	B	Di-n-butyl phthalate	BDL	390	BDL	380	BDL	350	BDL	340
427	B	2,4-Dinitrotoluene	BDL	390	BDL	380	BDL	350	BDL	340
428	B	2,6-Dinitrotoluene	BDL	390	BDL	380	BDL	350	BDL	340
429	B	Di-n-octyl phthalate	BDL	390	BDL	380	BDL	350	BDL	340
431	B	Fluoranthene	BDL	390	BDL	380	BDL	350	BDL	340
432	B	Fluorene	BDL	390	BDL	380	BDL	350	BDL	340
433	B	Hexachlorobenzene	BDL	390	BDL	380	BDL	350	BDL	340
434	B	Hexachlorobutadiene	BDL	390	BDL	380	BDL	350	BDL	340
435	B	Hexachlorocyclopentadiene	BDL	390	BDL	380	BDL	350	BDL	340
436	B	Hexachloroethane	BDL	390	BDL	380	BDL	350	BDL	340
437	B	Indeno(1,2,3-cd)pyrene	BDL	390	BDL	380	BDL	350	BDL	340
438	B	Isophorone	BDL	390	BDL	380	BDL	350	BDL	340
439	B	Naphthalene	BDL	390	BDL	380	BDL	350	BDL	340
440	B	Nitrobenzene	BDL	390	BDL	380	BDL	350	BDL	340
442	B	N-Nitroso-di-n-propylamine	BDL	390	BDL	380	BDL	350	BDL	340
443	B	N-Nitrosodiphenylamine(1)	BDL	390	BDL	380	BDL	350	BDL	340
444	B	Phenanthrene	BDL	390	BDL	380	BDL	350	BDL	340
445	B	Pyrene	BDL	390	BDL	380	BDL	350	BDL	340
446	B	1,2,4-Trichlorobenzene	BDL	390	BDL	380	BDL	350	BDL	340
474	B	Benzyl alcohol	BDL	390	BDL	380	BDL	350	BDL	340
475	B	4-Chloroaniline	BDL	390	BDL	380	BDL	350	BDL	340
476	B	Dibenzofuran	BDL	390	BDL	380	BDL	350	BDL	340
477	B	2-Methylnaphthalene	BDL	390	BDL	380	BDL	350	BDL	340
478	B	2-Nitroaniline	BDL	1900	BDL	1700	BDL	1700	BDL	1700
479	B	3-Nitroaniline	BDL	1900	BDL	1700	BDL	1700	BDL	1700
480	B	4-Nitroaniline	BDL	1900	BDL	1700	BDL	1700	BDL	1700
601	A	2-Chlorophenol	BDL	390	BDL	380	BDL	350	BDL	340
602	A	2,4-Dichlorophenol	BDL	390	BDL	380	BDL	350	BDL	340
603	A	2,4-Dimethylphenol	BDL	390	BDL	380	BDL	350	BDL	340
604	A	4,6-Dinitro-2-methylphenol	BDL	1900	BDL	1700	BDL	1700	BDL	1700
605	A	2,4-Dinitrophenol	BDL	1900	BDL	1700	BDL	1700	BDL	1700
606	A	2-Nitrophenol	BDL	390	BDL	380	BDL	350	BDL	340
607	A	4-Nitrophenol	BDL	1900	BDL	1700	BDL	1700	BDL	1700

			Boring 37							
LAB SAMPLE ID			B37-1		B37-2		B37-3		B37-4	
SAMPLING DATE			01/17/90		01/17/90		01/17/90		01/17/90	
DEPTH			8		18		24		32	
MATRIX			SOIL		SOIL		SOIL		SOIL	
UNITS			mg/kg		mg/kg		mg/kg		mg/kg	
CMP	CL	COMPOUND	ug/kg		ug/kg		ug/kg		ug/kg	
608	A	4-Chloro-3-methylphenol	BDL	390	BDL	360	BDL	350	BDL	340
609	A	Pentachlorophenol	BDL	1900	BDL	1700	BDL	1700	BDL	1700
610	A	Phenol	BDL	390	BDL	360	BDL	350	BDL	340
611	A	2,4,6-Trichlorophenol	BDL	390	BDL	360	BDL	350	BDL	340
620	A	2-Methylphenol	BDL	390	BDL	360	BDL	350	BDL	340
622	A	4-Methylphenol	BDL	390	BDL	360	BDL	350	BDL	340
625	A	Benzoic acid	BDL	1900	BDL	1700	BDL	1700	BDL	1700
626	A	2,4,5-Trichlorophenol	BDL	1900	BDL	1700	BDL	1700	BDL	1700
701	P	Aldrin	BDL	9.4	BDL	8.6	BDL	8.5	BDL	8.3
702	P	Alpha-BHC	BDL	9.4	BDL	8.6	BDL	8.5	BDL	8.3
703	P	Beta-BHC	BDL	9.4	BDL	8.6	BDL	8.5	BDL	8.3
704	P	Gamma-BHC (Lindane)	BDL	9.4	BDL	8.6	BDL	8.5	BDL	8.3
705	P	Delta-BHC	BDL	9.4	BDL	8.6	BDL	8.5	BDL	8.3
707	P	4,4'-DDT	BDL	19	BDL	17	BDL	17	BDL	16
708	P	4,4'-DDE	BDL	19	BDL	17	BDL	17	BDL	16
709	P	4,4'-DDD	BDL	19	BDL	17	BDL	17	BDL	16
710	P	Dieldrin	BDL	19	BDL	17	BDL	17	BDL	16
711	P	Endosulfan I	BDL	9.4	BDL	8.6	BDL	8.5	BDL	8.3
712	P	Endosulfan II	BDL	19	BDL	17	BDL	17	BDL	16
713	P	Endosulfan sulfate	BDL	19	BDL	17	BDL	17	BDL	16
714	P	Endrin	BDL	19	BDL	17	BDL	17	BDL	16
716	P	Heptachlor	BDL	9.4	BDL	8.6	BDL	8.5	BDL	8.3
717	P	Heptachlor epoxide	BDL	9.4	BDL	8.6	BDL	8.5	BDL	8.3
718	P	PCB-1242	BDL	94	BDL	86	BDL	85	BDL	83
719	P	PCB-1254	BDL	190	BDL	170	BDL	170	BDL	160
720	P	PCB-1221	BDL	94	BDL	86	BDL	85	BDL	83
721	P	PCB-1232	BDL	94	BDL	86	BDL	85	BDL	83
722	P	PCB-1248	BDL	94	BDL	86	BDL	85	BDL	83
723	P	PCB-1260	BDL	190	BDL	170	BDL	170	BDL	160
724	P	PCB-1016	BDL	94	BDL	86	BDL	85	BDL	83
725	P	Toxaphene	BDL	190	BDL	170	BDL	170	BDL	160
726	P	p,p'-Methoxychlor	BDL	94	BDL	86	BDL	85	BDL	83
739	P	Endrin ketone	BDL	19	BDL	17	BDL	17	BDL	16
747	P	Alpha chlordane	BDL	94	BDL	86	BDL	85	BDL	83
748	P	Gamma chlordane	BDL	94	BDL	86	BDL	85	BDL	83
1001	C	Cyanide	BDL	0.59	BDL	0.54	BDL	0.53	BDL	0.52
1047	C	pH	7.5		7.8		7.7		7.7	
1080	C	Percent Solids	84.8		92		94.1		95.9	
1082	C	% Moisture, Undecanted	15		8		6		4	

COLLIERVILLE SITE RI/FS: PHASE 1 SOIL BORINGS ANALYTICAL SUMMARY

			Boring 37		EPA QA Spike Samples	
LAB SAMPLE ID			B37-5	B37-6	B37-7	B37-8
SAMPLING DATE			01/17/90	01/17/90	01/17/90	01/17/90
DEPTH			40	48	0	0
MATRIX			SOIL	SOIL	SOIL	SOIL
GMP	CL	COMPOUND	mg/kg	mg/kg	mg/kg	mg/kg
101	M	Antimony	BDL 4400	BDL 4500	BDL 5300	
102	M	Arsenic	BDL 630	1500 B F N	BDL 750	
103	M	Beryllium	BDL 210	BDL 220	BDL 250	
104	M	Cadmium	BDL 1100	BDL 1100	BDL 1300	
105	M	Chromium	3800 P *	8400 P *	BDL 1300	
106	M	Copper	BDL 840	3000 B P	BDL 1000	
107	M	Lead	1600 F N	4000 F N	670 B F N	
108	M	Mercury	BDL 110	BDL 110	BDL 130	
109	M	Nickel	BDL 6100	BDL 6200	BDL 7300	
110	M	Selenium	BDL 2100	BDL 430	BDL 500	
111	M	Silver	BDL 840	BDL 860	BDL 1000	
112	M	Thallium	BDL 420	BDL 430	BDL 500	
113	M	Zinc	17200 P	6200 P	3300 B P	
114	M	Barium	5200 B P	7000 B P	630 B P	
115	M	Iron	2E+06 P *	5E+06 P *	127000 P *	
116	M	Manganese	6500 P *	13000 P *	1900 B P *	
117	M	Vanadium	3900 B P	8600 B P	630 B P	
118	M	Aluminum	2E+06 P	4E+06 P	327000 P	
120	M	Cobalt	BDL 630	1100 B P *	BDL 750	
121	M	Magnesium	62100 B P	90400 B P	BDL 14000	
129	M	Calcium	80900 B P	148000 B P	BDL 4300	
130	M	Sodium	BDL 313000	BDL 321000	BDL 373000	
131	M	Potassium	BDL 285000	BDL 271000	BDL 315000	
UNITS			ug/kg	ug/kg	ug/kg	ug/kg
203	V	Benzene	BDL 5	BDL 6	BDL 6	
205	V	Bromoform	BDL 5	BDL 6	BDL 6	
206	V	Carbon tetrachloride	BDL 5	BDL 6	BDL 6	
207	V	Chlorobenzene	BDL 5	BDL 6	BDL 6	
208	V	Dibromochloromethane	BDL 5	BDL 6	BDL 6	
209	V	Chloroethane	BDL 11	BDL 11	BDL 11	
211	V	Chloroform	BDL 5	BDL 6	BDL 6	
212	V	Bromodichloromethane	BDL 5	BDL 6	BDL 6	
214	V	1,1-Dichloroethane	BDL 5	BDL 6	BDL 6	
215	V	1,2-Dichloroethane	BDL 5	BDL 6	BDL 6	
216	V	1,1-Dichloroethene	BDL 5	BDL 6	BDL 6	
217	V	1,2-Dichloropropane	BDL 5	BDL 6	BDL 6	
218	V	Cis-1,3-Dichloropropene	BDL 5	BDL 6	BDL 6	
219	V	Ethylbenzene	BDL 5	BDL 6	BDL 6	
220	V	Bromomethane	BDL 11	BDL 11	BDL 11	
221	V	Chloromethane	BDL 11	BDL 11	BDL 11	
222	V	Methylene chloride	8 B	15 B	12 B	
223	V	1,1,2,2-Tetrachloroethane	BDL 5	BDL 6	BDL 6	
224	V	Tetrachloroethene	BDL 5	BDL 6	BDL 6	
225	V	Toluene	BDL 5	BDL 6	BDL 6	
227	V	1,1,1-Trichloroethane	BDL 5	BDL 6	BDL 6	
228	V	1,1,2-Trichloroethane	BDL 5	BDL 6	BDL 6	
229	V	Trichloroethene	BDL 5	BDL 6	BDL 6	
231	V	Vinyl chloride	BDL 11	BDL 11	BDL 11	
250	V	Trans-1,3-Dichloropropene	BDL 5	BDL 6	BDL 6	
251	V	Styrene	BDL 5	BDL 6	BDL 6	
252	V	Acetone	23 B	16 B	BDL 11	
253	V	2-Butanone	BDL 11	BDL 11	BDL 11	
254	V	Carbon disulfide	BDL 5	BDL 6	BDL 6	
255	V	2-Hexanone	BDL 11	BDL 11	BDL 11	
256	V	4-Methyl-2-pentanone	BDL 11	BDL 11	BDL 11	
257	V	Vinyl acetate	BDL 11	BDL 11	BDL 11	
289	V	Xylenes (Total)	BDL 5	BDL 6	BDL 6	
299	V	1,2-Dichloroethene(Total)	BDL 5	BDL 6	BDL 6	

LAB SAMPLE ID SAMPLING DATE DEPTH MATRIX CMP CL COMPOUND UNITS			Boring 37		EPA QA Spike Samples			
			B37-5	B37-6	B37-7	B37-8		
			01/17/90	01/17/90	01/17/90	01/17/90		
			40	48	0	0		
			SOIL	SOIL	SOIL	SOIL		
			mg/kg	mg/kg	mg/kg	mg/kg		
			ug/kg	ug/kg	ug/kg	ug/kg		
401	B	Acenaphthene	BDL	350	BDL	370	BDL	360
402	B	Acenaphthylene	BDL	350	BDL	370	BDL	360
403	B	Anthracene	BDL	350	BDL	370	BDL	360
405	B	Benzo(a)anthracene	BDL	350	BDL	370	700	360
406	B	Benzo(a)pyrene	BDL	350	BDL	370	BDL	360
407	B	Benzo(b)fluoranthene	BDL	350	BDL	370	750	360
408	B	Benzo(g,h,i)perylene	BDL	350	BDL	370	BDL	360
409	B	Benzo(k)fluoranthene	BDL	350	BDL	370	BDL	360
410	B	bis(2-Chloroethoxy)methane	BDL	350	BDL	370	BDL	360
411	B	bis(2-Chloroethyl)ether	BDL	350	BDL	370	BDL	360
412	B	bis(2-Chloroisopropyl)ether	BDL	350	BDL	370	BDL	360
413	B	bis(2-Ethylhexyl)phthalate	BDL	350	BDL	370	BDL	360
414	B	4-Bromophenyl phenyl ether	BDL	350	BDL	370	BDL	360
415	B	Butyl benzyl phthalate	BDL	350	BDL	370	BDL	360
416	B	2-Chloronaphthalene	BDL	350	BDL	370	BDL	360
417	B	4-Chlorophenyl phenyl ether	BDL	350	BDL	370	BDL	360
418	B	Chrysene	BDL	350	BDL	370	BDL	360
419	B	Dibenzo(a,h)anthracene	BDL	350	BDL	370	680	360
420	B	1,2-Dichlorobenzene	BDL	350	BDL	370	BDL	360
421	B	1,3-Dichlorobenzene	BDL	350	BDL	370	BDL	360
422	B	1,4-Dichlorobenzene	BDL	350	BDL	370	BDL	360
423	B	3,3'-Dichlorobenzidine	BDL	690	BDL	730	BDL	360
424	B	Diethyl phthalate	BDL	350	BDL	370	740	720
425	B	Dimethyl phthalate	BDL	350	BDL	370	BDL	360
426	B	Di-n-butyl phthalate	BDL	350	BDL	370	BDL	360
427	B	2,4-Dinitrotoluene	BDL	350	BDL	370	880	360
428	B	2,6-Dinitrotoluene	BDL	350	BDL	370	BDL	360
429	B	Di-n-octyl phthalate	BDL	350	BDL	370	800	360
431	B	Fluoranthene	BDL	350	BDL	370	BDL	360
432	B	Fluorene	BDL	350	BDL	370	BDL	360
433	B	Hexachlorobenzene	BDL	350	BDL	370	BDL	360
434	B	Hexachlorobutadiene	BDL	350	BDL	370	BDL	360
435	B	Hexachlorocyclopentadiene	BDL	350	BDL	370	BDL	360
436	B	Hexachloroethane	BDL	350	BDL	370	BDL	360
437	B	Indeno(1,2,3-cd)pyrene	BDL	350	BDL	370	BDL	360
438	B	Isochlorane	BDL	350	BDL	370	BDL	360
439	B	Naphthalene	BDL	350	BDL	370	BDL	360
440	B	Nitrobenzene	BDL	350	BDL	370	BDL	360
442	B	N-Nitroso-di-n-propylamine	BDL	350	BDL	370	41 J	360
443	B	N-Nitrosodiphenylamine(1)	BDL	350	BDL	370	BDL	360
444	B	Phenanthrene	BDL	350	BDL	370	BDL	360
445	B	Pyrene	BDL	350	BDL	370	BDL	360
446	B	1,2,4-Trichlorobenzene	BDL	350	BDL	370	BDL	360
474	B	Benzyl alcohol	BDL	350	BDL	370	BDL	360
475	B	4-Chloroaniline	BDL	350	BDL	370	BDL	360
476	B	Dibenzofuran	BDL	350	BDL	370	78 J	360
477	B	2-Methylnaphthalene	BDL	350	BDL	370	BDL	360
478	B	2-Nitroaniline	BDL	1700	BDL	1800	BDL	1700
479	B	3-Nitroaniline	BDL	1700	BDL	1800	BDL	1700
480	B	4-Nitroaniline	BDL	1700	BDL	1800	BDL	1700
601	A	2-Chlorophenol	BDL	350	BDL	370	BDL	1700
602	A	2,4-Dichlorophenol	BDL	350	BDL	370	BDL	360
603	A	2,4-Dimethylphenol	BDL	350	BDL	370	BDL	360
604	A	4,6-Dinitro-2-methylphenol	BDL	1700	BDL	1800	BDL	1700
605	A	2,4-Dinitrophenol	BDL	1700	BDL	1800	BDL	1700
606	A	2-Nitrophenol	BDL	350	BDL	370	BDL	360
607	A	4-Nitrophenol	BDL	1700	BDL	1800	BDL	1700

COLLIERVILLE SITE R/FS: PHASE 1 SOIL BORINGS ANALYTICAL SUMMARY

			Boring 37				EPA QA Spike Samples			
LAB SAMPLE ID			B37-5		B37-6		B37-7		B37-8	
SAMPLING DATE			01/17/90		01/17/90		01/17/90		01/17/90	
DEPTH			40		48		0		0	
MATRIX			SOIL		SOIL		SOIL		SOIL	
CMP	CL	COMPOUND	UNITS		UNITS		UNITS		UNITS	
			mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
			ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
608	A	4-Chloro-3-methylphenol	BDL	350	BDL	370	BDL	370	BDL	360
609	A	Pentachlorophenol	BDL	1700	BDL	1800	BDL	1800	BDL	1700
610	A	Phenol	BDL	350	BDL	370	BDL	370	1100	
611	A	2,4,6-Trichlorophenol	BDL	350	BDL	370	BDL	370	1600	
620	A	2-Methylphenol	BDL	350	BDL	370	BDL	370	1200	
622	A	4-Methylphenol	BDL	350	BDL	370	BDL	370	BDL	360
625	A	Benzoic acid	BDL	1700	BDL	1800	BDL	1800	BDL	1700
628	A	2,4,5-Trichlorophenol	BDL	1700	BDL	1800	BDL	1800	BDL	1700
701	P	Aldrin	BDL	8.4	BDL	8.9	BDL	8.9	BDL	8.8
702	P	Alpha-BHC	BDL	8.4	BDL	8.9	BDL	8.9	BDL	8.8
703	P	Beta-BHC	BDL	8.4	BDL	8.9	BDL	8.9	BDL	8.8
704	P	Gamma-BHC (Lindane)	BDL	8.4	BDL	8.9	BDL	8.9	BDL	8.8
705	P	Delta-BHC	BDL	8.4	BDL	8.9	BDL	8.9	BDL	8.8
707	P	4,4'-DDT	BDL	17	BDL	18	BDL	18	BDL	17
708	P	4,4'-DDE	BDL	17	BDL	18	BDL	18	BDL	17
709	P	4,4'-DDD	BDL	17	BDL	18	BDL	18	BDL	17
710	P	Dieldrin	BDL	17	BDL	18	BDL	18	22	
711	P	Endosulfan I	BDL	8.4	BDL	8.9	BDL	8.9	11	
712	P	Endosulfan II	BDL	17	BDL	18	BDL	18	BDL	17
713	P	Endosulfan sulfate	BDL	17	BDL	18	BDL	18	BDL	17
714	P	Endrin	BDL	17	BDL	18	BDL	18	BDL	17
716	P	Heptachlor	BDL	8.4	BDL	8.9	BDL	8.9	BDL	8.8
717	P	Heptachlor epoxide	BDL	8.4	BDL	8.9	BDL	8.9	BDL	8.8
718	P	PCB-1242	BDL	84	BDL	89	BDL	89	BDL	86
719	P	PCB-1254	BDL	170	BDL	180	BDL	180	BDL	170
720	P	PCB-1221	BDL	84	BDL	89	BDL	89	BDL	86
721	P	PCB-1232	BDL	84	BDL	89	BDL	89	BDL	86
722	P	PCB-1248	BDL	84	BDL	89	BDL	89	BDL	86
723	P	PCB-1260	BDL	170	BDL	180	BDL	180	BDL	170
724	P	PCB-1016	BDL	84	BDL	89	BDL	89	BDL	86
725	P	Toxaphene	BDL	170	BDL	180	BDL	180	BDL	170
726	P	p,p'-Methoxychlor	BDL	84	BDL	89	BDL	89	BDL	86
739	P	Endrin ketone	BDL	17	BDL	18	BDL	18	BDL	17
747	P	Alpha chlordane	BDL	84	BDL	89	BDL	89	BDL	86
748	P	Gamma chlordane	BDL	84	BDL	89	BDL	89	BDL	86
1001	C	Cyanide	BDL	0.52	BDL	0.55	BDL	0.63		
1047	C	pH		7.6		7.1		7.4		7.4
1080	C	Percent Solids		95.2		91		79.2		
1082	C	% Moisture, Undecanted		5		10		11		8

				Boring 38							
LAB SAMPLE ID				B38-1		B38-2		B38-3		B38-4	
SAMPLING DATE				01/17/90		01/17/90		01/17/90		01/17/90	
DEPTH				10		18		24		32	
MATRIX				SOIL		SOIL		SOIL		SOIL	
UNITS				mg/kg		mg/kg		mg/kg		mg/kg	
CMP	CL	COMPOUND									
101	M	Antimony		BDL	5200	BDL	4900	BDL	5200	BDL	4300
102	M	Arsenic		12500	+ N * F	1500	B S N *	3300	B S N *	BDL	820
103	M	Beryllium		290	B P	BDL	230	840	B P	BDL	200
104	M	Cadmium		BDL	1200	BDL	1200	BDL	1200	BDL	1000
105	M	Chromium		24400	P	17400	P	20400	P	6600	P
106	M	Copper		18800	P	7700	P	10400	P	BDL	820
107	M	Lead		15800	F	8700	F	9700	F	1700	F
108	M	Mercury		BDL	100	BDL	110	BDL	100	BDL	100
109	M	Nickel		29700	P	13700	P	14500	P	BDL	5900
110	M	Selenium		BDL	2500	BDL	450	BDL	490	BDL	2100
111	M	Silver		BDL	990	BDL	930	BDL	990	BDL	820
112	M	Thallium		BDL	490	BDL	450	BDL	490	BDL	410
113	M	Zinc		72200	P	31400	P	39000	P	4500	P
114	M	Barium		430000	P	110000	P	82300	P	7100	B P
115	M	Iron		3E+07	P	1E+07	P	2E+07	P	1E+06	P
116	M	Manganese		2E+06	P	423000	P	326000	P	51200	P
117	M	Vanadium		41800	E P	30300	E P	24900	E P	8600	B E P
118	M	Aluminum		2E+07	P	2E+07	P	2E+07	P	3E+06	P
120	M	Cobalt		20000	P	6300	B P	4500	B P	670	B P
121	M	Magnesium		3E+06	E P	2E+06	E P	2E+06	E P	119000	B E P
129	M	Calcium		2E+06	* P	1E+06	* P	2E+06	* P	160000	B * P
130	M	Sodium		1E+06	B P	BDL	345000	BDL	370000	BDL	305000
131	M	Potassium		2E+06	P	BDL	291000	BDL	313000	BDL	313000 B P
UNITS				ug/kg		ug/kg		ug/kg		ug/kg	
203	V	Benzene		BDL	39000	BDL	6	BDL	6	BDL	5
205	V	Bromoform		BDL	39000	BDL	6	BDL	6	BDL	5
206	V	Carbon tetrachloride		BDL	39000	BDL	6	BDL	6	BDL	5
207	V	Chlorobenzene		BDL	39000	BDL	6	BDL	6	BDL	5
208	V	Dibromochloromethane		BDL	39000	BDL	6	BDL	6	BDL	5
209	V	Chloroethane		BDL	77000	BDL	12	BDL	13	BDL	10
211	V	Chloroform		BDL	39000	BDL	6	BDL	6	BDL	5
212	V	Bromodichloromethane		BDL	39000	BDL	6	BDL	6	BDL	5
214	V	1,1-Dichloroethane		BDL	39000	BDL	6	BDL	6	BDL	5
215	V	1,2-Dichloroethane		BDL	39000	BDL	6	BDL	6	BDL	5
216	V	1,1-Dichloroethene		BDL	39000	BDL	6	BDL	6	BDL	5
217	V	1,2-Dichloropropane		BDL	39000	BDL	6	BDL	6	BDL	5
218	V	Cis-1,3-Dichloropropene		BDL	39000	BDL	6	BDL	6	BDL	5
219	V	Ethylbenzene		BDL	39000	BDL	6	BDL	6	BDL	5
220	V	Bromomethane		BDL	77000	BDL	12	BDL	13	BDL	10
221	V	Chloromethane		BDL	77000	BDL	12	BDL	13	BDL	10
222	V	Methylene chloride		17	B	31	B	18	B	16	B
223	V	1,1,2,2-Tetrachloroethane		BDL	39000	BDL	6	BDL	6	BDL	5
224	V	Tetrachloroethene		11		BDL	6	BDL	6	BDL	5
225	V	Toluene		87		BDL	6	BDL	6	2	J
227	V	1,1,1-Trichloroethane		BDL	39000	BDL	6	BDL	6	BDL	5
228	V	1,1,2-Trichloroethane		26		BDL	6	BDL	6	BDL	5
229	V	Trichloroethene		1E+6	D	1	J	BDL	6	BDL	5
231	V	Vinyl chloride		BDL	77000	BDL	12	BDL	13	BDL	10
250	V	Trans-1,3-Dichloropropene		BDL	39000	BDL	6	BDL	6	BDL	5
251	V	Styrene		BDL	39000	BDL	6	BDL	6	BDL	5
252	V	Acetone		49	B	29	B	45	B	52	B
253	V	2-Butanone		190		BDL	12	BDL	13	BDL	10
254	V	Carbonyl disulfide		BDL	39000	BDL	6	BDL	6	BDL	5
255	V	2-Hexanone		BDL	77000	BDL	12	BDL	13	BDL	10
256	V	4-Methyl-2-pentanone		BDL	77000	BDL	12	BDL	13	BDL	10
257	V	Vinyl acetate		BDL	77000	BDL	12	BDL	13	BDL	10
289	V	Xylenes (Total)		3	J	BDL	6	BDL	6	BDL	5
299	V	1,2-Dichloroethene (Total)		200		BDL	6	BDL	6	BDL	5

			Boring 38							
LAB SAMPLE ID			B38-1		B38-2		B38-3		B38-4	
SAMPLING DATE			01/17/90		01/17/90		01/17/90		01/17/90	
DEPTH			10		16		24		32	
MATRIX			SOIL		SOIL		SOIL		SOIL	
UNITS			mg/kg		mg/kg		mg/kg		mg/kg	
CMP	CL	COMPOUND	ug/kg		ug/kg		ug/kg		ug/kg	
401	B	Acenaphthene	BDL	410	BDL	380	BDL	410	BDL	340
402	B	Acenaphthylene	BDL	410	BDL	380	BDL	410	BDL	340
403	B	Anthracene	BDL	410	BDL	380	BDL	410	BDL	340
405	B	Benzo(a)anthracene	BDL	410	BDL	380	BDL	410	BDL	340
406	B	Benzo(a)pyrene	BDL	410	BDL	380	BDL	410	BDL	340
407	B	Benzo(b)fluoranthene	BDL	410	BDL	380	BDL	410	BDL	340
408	B	Benzo(g,h,i)perylene	BDL	410	BDL	380	BDL	410	BDL	340
409	B	Benzo(k)fluoranthene	BDL	410	BDL	380	BDL	410	BDL	340
410	B	bis(2-Chloroethoxy)methane	BDL	410	BDL	380	BDL	410	BDL	340
411	B	bis(2-Chloroethyl)ether	BDL	410	BDL	380	BDL	410	BDL	340
412	B	bis(2-Chloroisopropyl)ether	BDL	410	BDL	380	BDL	410	BDL	340
413	B	bis(2-Ethylhexyl)phthalate	1000		BDL	380	110 J		BDL	340
414	B	4-Bromophenyl phenyl ether	BDL	410	BDL	380	BDL	410	BDL	340
415	B	Butyl benzyl phthalate	BDL	410	BDL	380	BDL	410	BDL	340
416	B	2-Chloronaphthalene	BDL	410	BDL	380	BDL	410	BDL	340
417	B	4-Chlorophenyl phenyl ether	BDL	410	BDL	380	BDL	410	BDL	340
418	B	Chrysene	BDL	410	BDL	380	BDL	410	BDL	340
419	B	Dibenzo(a,h)anthracene	BDL	410	BDL	380	BDL	410	BDL	340
420	B	1,2-Dichlorobenzene	BDL	410	BDL	380	BDL	410	BDL	340
421	B	1,3-Dichlorobenzene	BDL	410	BDL	380	BDL	410	BDL	340
422	B	1,4-Dichlorobenzene	BDL	410	BDL	380	BDL	410	BDL	340
423	B	3,3'-Dichlorobenzidine	BDL	820	BDL	770	BDL	830	BDL	690
424	B	Diethyl phthalate	BDL	410	BDL	380	BDL	410	BDL	340
425	B	Dimethyl phthalate	BDL	410	BDL	380	BDL	410	BDL	340
426	B	Di-n-butyl phthalate	BDL	410	BDL	380	BDL	410	BDL	340
427	B	2,4-Dinitrotoluene	BDL	410	BDL	380	BDL	410	BDL	340
428	B	2,6-Dinitrotoluene	BDL	410	BDL	380	BDL	410	BDL	340
429	B	Di-n-octyl phthalate	BDL	410	BDL	380	BDL	410	BDL	340
431	B	Fluoranthene	BDL	410	BDL	380	BDL	410	BDL	340
432	B	Fluorene	BDL	410	BDL	380	BDL	410	BDL	340
433	B	Hexachlorobenzene	BDL	410	BDL	380	BDL	410	BDL	340
434	B	Hexachlorobutadiene	BDL	410	BDL	380	BDL	410	BDL	340
435	B	Hexachlorocyclopentadiene	BDL	410	BDL	380	BDL	410	BDL	340
436	B	Hexachloroethane	BDL	410	BDL	380	BDL	410	BDL	340
437	B	Indeno(1,2,3-cd)pyrene	BDL	410	BDL	380	BDL	410	BDL	340
438	B	Isophorone	BDL	410	BDL	380	BDL	410	BDL	340
439	B	Naphthalene	BDL	410	BDL	380	BDL	410	BDL	340
440	B	Nitrobenzene	BDL	410	BDL	380	BDL	410	BDL	340
442	B	N-Nitroso-di-n-propylamine	BDL	410	BDL	380	BDL	410	BDL	340
443	B	N-Nitrosodiphenylamine(1)	BDL	410	BDL	380	BDL	410	BDL	340
444	B	Phenanthrene	180 J		BDL	380	BDL	410	BDL	340
445	B	Pyrene	BDL	410	BDL	380	BDL	410	BDL	340
446	B	1,2,4-Trichlorobenzene	BDL	410	BDL	380	BDL	410	BDL	340
474	B	Benzyl alcohol	BDL	410	BDL	380	BDL	410	BDL	340
475	B	4-Chloroaniline	BDL	410	BDL	380	BDL	410	BDL	340
476	B	Dibenzofuran	BDL	410	BDL	380	BDL	410	BDL	340
477	B	2-Methylnaphthalene	BDL	410	BDL	380	BDL	410	BDL	340
478	B	2-Nitroaniline	BDL	2000	BDL	1900	BDL	2000	BDL	1700
479	B	3-Nitroaniline	BDL	2000	BDL	1900	BDL	2000	BDL	1700
480	B	4-Nitroaniline	BDL	2000	BDL	1900	BDL	2000	BDL	1700
601	A	2-Chlorophenol	BDL	410	BDL	380	BDL	410	BDL	340
602	A	2,4-Dichlorophenol	BDL	410	BDL	380	BDL	410	BDL	340
603	A	2,4-Dimethylphenol	BDL	410	BDL	380	BDL	410	BDL	340
604	A	4,6-Dinitro-2-methylphenol	BDL	2000	BDL	1900	BDL	2000	BDL	1700
605	A	2,4-Dinitrophenol	BDL	2000	BDL	1900	BDL	2000	BDL	1700
606	A	2-Nitrophenol	BDL	410	BDL	380	BDL	410	BDL	340
607	A	4-Nitrophenol	BDL	2000	BDL	1900	BDL	2000	BDL	1700

COLLIERVILLE SITE R/VFS: PHASE 1 SOIL BORINGS ANALYTICAL SUMMARY

			Boring 38							
LAB SAMPLE ID			B38-1		B38-2		B38-3		B38-4	
SAMPLING DATE			01/17/90		01/17/90		01/17/90		01/17/90	
DEPTH			10		16		24		32	
MATRIX			SOIL		SOIL		SOIL		SOIL	
UNITS			mg/kg		mg/kg		mg/kg		mg/kg	
CMP	CL	COMPOUND	ug/kg		ug/kg		ug/kg		ug/kg	
608	A	4-Chloro-3-methylphenol	BDL	410	BDL	380	BDL	410	BDL	340
609	A	Pentachlorophenol	BDL	2000	BDL	1900	BDL	2000	BDL	1700
610	A	Phenol	BDL	410	BDL	380	BDL	410	BDL	340
611	A	2,4,6-Trichlorophenol	BDL	410	BDL	380	BDL	410	BDL	340
620	A	2-Methylphenol	BDL	410	BDL	380	BDL	410	BDL	340
622	A	4-Methylphenol	BDL	410	BDL	380	BDL	410	BDL	340
625	A	Benzoic acid	BDL	2000	BDL	1900	BDL	2000	BDL	1700
626	A	2,4,5-Trichlorophenol	BDL	2000	BDL	1900	BDL	2000	BDL	1700
701	P	Aldrin	BDL	9.8	BDL	9.1	BDL	9.7	BDL	8.2
702	P	Alpha-BHC	BDL	9.8	BDL	9.1	BDL	9.7	BDL	8.2
703	P	Beta-BHC	BDL	9.8	BDL	9.1	BDL	9.7	BDL	8.2
704	P	Gamma-BHC (Lindane)	BDL	9.8	BDL	9.1	BDL	9.7	BDL	8.2
705	P	Delta-BHC	BDL	9.8	BDL	9.1	BDL	9.7	BDL	8.2
707	P	4,4'-DDT	BDL	20	BDL	18	BDL	19	BDL	16
708	P	4,4'-DDE	BDL	20	BDL	18	BDL	19	BDL	16
709	P	4,4'-DDD	BDL	20	BDL	18	BDL	19	BDL	16
710	P	Dieldrin	BDL	20	BDL	18	BDL	19	BDL	16
711	P	Endosulfan I	BDL	9.8	BDL	9.1	BDL	9.7	BDL	8.2
712	P	Endosulfan II	BDL	20	BDL	18	BDL	19	BDL	16
713	P	Endosulfan sulfate	BDL	20	BDL	18	BDL	19	BDL	16
714	P	Endrin	BDL	20	BDL	18	BDL	19	BDL	16
716	P	Heptachlor	BDL	9.8	BDL	9.1	BDL	9.7	BDL	8.2
717	P	Heptachlor epoxide	BDL	9.8	BDL	9.1	BDL	9.7	BDL	8.2
718	P	PCB-1242	BDL	98	BDL	91	BDL	97	BDL	82
719	P	PCB-1254	BDL	200	BDL	180	BDL	190	BDL	160
720	P	PCB-1221	BDL	98	BDL	91	BDL	97	BDL	82
721	P	PCB-1232	BDL	98	BDL	91	BDL	97	BDL	82
722	P	PCB-1248	BDL	98	BDL	91	BDL	97	BDL	82
723	P	PCB-1260	BDL	200	BDL	180	BDL	190	BDL	160
724	P	PCB-1016	BDL	98	BDL	91	BDL	97	BDL	82
725	P	Toxaphene	BDL	200	BDL	180	BDL	190	BDL	160
726	P	p,p'-Methoxychlor	BDL	98	BDL	91	BDL	97	BDL	82
739	P	Endrin ketone	BDL	20	BDL	18	BDL	19	BDL	16
747	P	Alpha chlordane	BDL	98	BDL	91	BDL	97	BDL	82
748	P	Gamma chlordane	BDL	98	BDL	91	BDL	97	BDL	82
1001	C	Cyanide	BDL	0.62	BDL	0.58	BDL	0.62	BDL	0.52
1047	C	pH		6.8		7.5		7		7
1080	C	Percent Solids		81.2		85.6		80.5		95.8
1082	C	% Moisture, Undecanted		19		14		20		4

			Boring 38	
LAB SAMPLE ID			B38-5	B38-6
SAMPLING DATE			01/17/90	01/17/90
DEPTH			40	48
MATRIX			SOIL	SOIL
CMP	CL	COMPOUND	mg/kg	mg/kg
101	M	Antimony	BDL	4400
102	M	Arsenic	57500 P	1100 B N * F
103	M	Beryllium	1200 P	1300 P
104	M	Cadmium	BDL	1100
105	M	Chromium	16800 P	14900 P
106	M	Copper	BDL	870
107	M	Lead	11700 F	5800 F
108	M	Mercury	BDL	100
109	M	Nickel	BDL	8300
110	M	Selenium	BDL	420
111	M	Silver	BDL	870
112	M	Thallium	BDL	420
113	M	Zinc	45300 P	44700 P
114	M	Barium	30600 B P	17800 B P
115	M	Iron	4E+07 P	2E+07 P
116	M	Manganese	187000 P	62500 P
117	M	Vanadium	14800 E P	25200 E P
118	M	Aluminum	8E+06 P	9E+06 P
120	M	Cobalt	7000 B P	3100 B P
121	M	Magnesium	477000 B E P	1E+06 E P
129	M	Calcium	473000 B * P	2E+06 * P
130	M	Sodium	392000 B P	BDL
131	M	Potassium	582000 B P	889000 B P
UNITS:			ug/kg	ug/kg
203	V	Benzene	BDL	14
205	V	Bromoform	BDL	14
206	V	Carbon tetrachloride	BDL	14
207	V	Chlorobenzene	BDL	14
208	V	Dibromochloromethane	BDL	14
209	V	Chloroethane	BDL	27
211	V	Chloroform	BDL	14
212	V	Bromodichloromethane	BDL	14
214	V	1,1-Dichloroethane	BDL	14
215	V	1,2-Dichloroethane	BDL	14
216	V	1,1-Dichloroethene	BDL	14
217	V	1,2-Dichloropropane	BDL	14
218	V	Cis-1,3-Dichloropropene	BDL	14
219	V	Ethylbenzene	BDL	14
220	V	Bromomethane	BDL	27
221	V	Chloromethane	BDL	27
222	V	Methylene chloride	15 B	17 B
223	V	1,1,2,2-Tetrachloroethane	BDL	14
224	V	Tetrachloroethene	BDL	14
225	V	Toluene	BDL	14
227	V	1,1,1-Trichloroethane	BDL	14
228	V	1,1,2-Trichloroethane	BDL	14
229	V	Trichloroethene	3 J	BDL
231	V	Vinyl chloride	BDL	27
250	V	Trans-1,3-Dichloropropene	BDL	14
251	V	Styrene	BDL	14
252	V	Acetone	330 B E	51 B
253	V	2-Butanone	BDL	27
254	V	Carbon disulfide	BDL	14
255	V	2-Hexanone	BDL	27
256	V	4-Methyl-2-pentanone	BDL	27
257	V	Vinyl acetate	BDL	27
289	V	Xylenes (Total)	BDL	14
299	V	1,2-Dichloroethene (Total)	BDL	14

				Boring 38			
LAB SAMPLE ID				B38-5		B38-6	
SAMPLING DATE				01/17/90		01/17/90	
DEPTH				40		48	
MATRIX				SOIL		SOIL	
UNITS				mg/kg		mg/kg	
CMP	CL	COMPOUND	UNITS	ug/kg		ug/kg	
401	B	Acenaphthene		BDL	380	BDL	410
402	B	Acenaphthylene		BDL	380	BDL	410
403	B	Anthracene		BDL	380	BDL	410
405	B	Benzo(a)anthracene		BDL	380	BDL	410
406	B	Benzo(a)pyrene		BDL	380	BDL	410
407	B	Benzo(b)fluoranthene		BDL	380	BDL	410
408	B	Benzo(g,h,i)perylene		BDL	380	BDL	410
409	B	Benzo(k)fluoranthene		BDL	380	BDL	410
410	B	bis(2-Chloroethoxy)methane		BDL	380	BDL	410
411	B	bis(2-Chloroethyl)ether		BDL	380	BDL	410
412	B	bis(2-Chloroisopropyl)ether		BDL	380	BDL	410
413	B	bis(2-Ethylhexyl)phthalate		140 J		180 J	
414	B	4-Bromophenyl phenyl ether		BDL	380	BDL	410
415	B	Butyl benzyl phthalate		BDL	380	BDL	410
416	B	2-Chloronaphthalene		BDL	380	BDL	410
417	B	4-Chlorophenyl phenyl ether		BDL	380	BDL	410
418	B	Chrysene		BDL	380	BDL	410
419	B	Dibenzo(a,h)anthracene		BDL	380	BDL	410
420	B	1,2-Dichlorobenzene		BDL	380	BDL	410
421	B	1,3-Dichlorobenzene		BDL	380	BDL	410
422	B	1,4-Dichlorobenzene		BDL	380	BDL	410
423	B	3,3'-Dichlorobenzidine		BDL	720	BDL	820
424	B	Diethyl phthalate		BDL	380	BDL	410
425	B	Dimethyl phthalate		BDL	380	BDL	410
426	B	Di-n-butyl phthalate		BDL	380	BDL	410
427	B	2,4-Dinitrotoluene		BDL	380	BDL	410
428	B	2,6-Dinitrotoluene		BDL	380	BDL	410
429	B	Di-n-octyl phthalate		BDL	380	BDL	410
431	B	Fluoranthene		BDL	380	BDL	410
432	B	Fluorene		BDL	380	BDL	410
433	B	Hexachlorobenzene		BDL	380	BDL	410
434	B	Hexachlorobutadiene		BDL	380	BDL	410
436	B	Hexachlorocyclopentadiene		BDL	380	BDL	410
438	B	Hexachloroethane		BDL	380	BDL	410
437	B	Indeno(1,2,3-cd)pyrene		BDL	380	BDL	410
438	B	Isophorone		BDL	380	BDL	410
439	B	Naphthalene		BDL	380	BDL	410
440	B	Nitrobenzene		BDL	380	BDL	410
442	B	N-Nitroso-di-n-propylamine		BDL	380	BDL	410
443	B	N-Nitrosodiphenylamine(1)		BDL	380	BDL	410
444	B	Phenanthrene		BDL	380	BDL	410
445	B	Pyrene		BDL	380	BDL	410
446	B	1,2,4-Trichlorobenzene		BDL	380	BDL	410
474	B	Benzyl alcohol		BDL	380	BDL	410
475	B	4-Chloroaniline		BDL	380	BDL	410
476	B	Dibenzofuran		BDL	380	BDL	410
477	B	2-Methylnaphthalene		BDL	380	BDL	410
478	B	2-Nitroaniline		BDL	1700	BDL	2000
479	B	3-Nitroaniline		BDL	1700	BDL	2000
480	B	4-Nitroaniline		BDL	1700	BDL	2000
601	A	2-Chlorophenol		BDL	380	BDL	410
602	A	2,4-Dichlorophenol		BDL	380	BDL	410
603	A	2,4-Dimethylphenol		BDL	380	BDL	410
604	A	4,6-Dinitro-2-methylphenol		BDL	1700	BDL	2000
605	A	2,4-Dinitrophenol		BDL	1700	BDL	2000
606	A	2-Nitrophenol		BDL	380	BDL	410
607	A	4-Nitrophenol		BDL	1700	BDL	2000

		Boring 38			
		B38-5		B38-6	
LAB SAMPLE ID		01/17/90		01/17/90	
SAMPLING DATE		40		48	
DEPTH					
MATRIX		SOIL		SOIL	
CMP	CL COMPOUND	UNITS	mg/kg	mg/kg	
		UNITS	ug/kg	ug/kg	
608	A 4-Chloro-3-methylphenol	BDL	380	BDL	410
609	A Pentachlorophenol	BDL	1700	BDL	2000
610	A Phenol	BDL	380	BDL	410
611	A 2,4,6-Trichlorophenol	BDL	380	BDL	410
620	A 2-Methylphenol	BDL	380	BDL	410
622	A 4-Methylphenol	BDL	380	BDL	410
625	A Benzoic acid	BDL	1700	BDL	2000
626	A 2,4,5-Trichlorophenol	BDL	1700	BDL	2000
701	P Aldrin	BDL	8.5	BDL	9.7
702	P Alpha-BHC	BDL	8.5	BDL	9.7
703	P Beta-BHC	BDL	8.5	BDL	9.7
704	P Gamma-BHC (Lindane)	BDL	8.5	BDL	9.7
705	P Delta-BHC	BDL	8.5	BDL	9.7
707	P 4,4'-DDT	BDL	17	BDL	19
708	P 4,4'-DDE	BDL	17	BDL	19
709	P 4,4'-DDD	BDL	17	BDL	19
710	P Dieldrin	BDL	17	BDL	19
711	P Endosulfan I	BDL	8.5	BDL	9.7
712	P Endosulfan II	BDL	17	BDL	19
713	P Endosulfan sulfate	BDL	17	BDL	19
714	P Endrin	BDL	17	BDL	19
716	P Heptachlor	BDL	8.5	BDL	9.7
717	P Heptachlor epoxide	BDL	8.5	BDL	9.7
718	P PCB-1242	BDL	85	BDL	97
719	P PCB-1254	BDL	170	BDL	190
720	P PCB-1221	BDL	85	BDL	97
721	P PCB-1232	BDL	85	BDL	97
722	P PCB-1248	BDL	85	BDL	97
723	P PCB-1260	BDL	170	BDL	190
724	P PCB-1016	BDL	85	BDL	97
725	P Toxaphene	BDL	170	BDL	190
726	P p,p'-Methoxychlor	BDL	85	BDL	97
739	P Endrin ketone	BDL	17	BDL	19
747	P Alpha chlordane	BDL	85	BDL	97
748	P Gamma chlordane	BDL	85	BDL	97
1001	C Cyanide	BDL	0.54	BDL	0.61
1047	C pH		6.4		6
1080	C Percent Solids		92.4		80.7
1082	C % Moisture, Undecanted		8		19

COLLIERVILLE SITE RI/FS:PHASE 1 SOIL BORINGS ANALYTICAL SUMMARY

LAB SAMPLE ID DATE DEPTH MATRIX UNITS			Boring 39			
			B39-1	B39-2	B39-3	B39-4
			01/21/90	01/21/90	01/21/90	01/21/90
			8	16	24	34
CMP	CL	COMPOUND	SOIL mg/kg	SOIL mg/kg	SOIL mg/kg	SOIL mg/kg
101	M	Antimony	BDL	5.2	BDL	4.7
102	M	Arsenic	4.4 B F N	4.5 B F N	BDL	0.67
103	M	Beryllium	0.86 B P	0.86 B P	0.4 B P	BDL
104	M	Cadmium	BDL	1.2	BDL	1.1
105	M	Chromium	25.8 P *	22.5 P *	10.7 P *	10.9 P *
106	M	Copper	17.3 P	12 P	6 P	2.1 B P
107	M	Lead	11.9 F N	21.4 F N	5.9 F N	1.3 F N
108	M	Mercury	BDL	0.12	BDL	0.11
109	M	Nickel	18.2 P	14.3 P	8.2 B P	BDL
110	M	Selenium	BDL	2.5	BDL	2.2
111	M	Silver	BDL	1	BDL	0.9
112	M	Thallium	BDL	0.5	BDL	0.45
113	M	Zinc	77.8 P *	38.8 P *	18.6 P *	5.3 P *
114	M	Barium	188 P	110 P	42 B P	5.9 B P
115	M	Iron	24000 P	18300 P	7890 P	2500 P
116	M	Manganese	233 P N *	244 P N *	268 P N *	18.4 P N *
117	M	Vanadium	37 P	36.6 P	16.7 P	8.6 B P
118	M	Aluminum	22300 P *	17400 P *	10800 P *	3080 P *
120	M	Cobalt	6.1 B P	6.3 B P	3.9 B P	BDL
121	M	Magnesium	3100 P	1980 P	801 B P	147 B P
129	M	Calcium	1110 B P	1250 P	730 B P	205 B P
130	M	Sodium	43400 P *	377 B P *	BDL	336
131	M	Potassium	796 B P	511 B P	430 B P	BDL
UNITS			ug/kg	ug/kg	ug/kg	ug/kg
203	V	Benzene	BDL	6	BDL	6
205	V	Bromoform	BDL	6	BDL	6
206	V	Carbon tetrachloride	BDL	6	BDL	6
207	V	Chlorobenzene	BDL	6	BDL	6
208	V	Dibromochloromethane	BDL	6	BDL	6
209	V	Chloroethane	BDL	13	BDL	11
211	V	Chloroform	BDL	6	BDL	6
212	V	Bromodichloromethane	BDL	6	BDL	6
214	V	1,1-Dichloroethane	BDL	6	BDL	6
215	V	1,2-Dichloroethane	BDL	6	BDL	6
216	V	1,1-Dichloroethene	BDL	6	BDL	6
217	V	1,2-Dichloropropane	BDL	6	BDL	6
218	V	Cis-1,3-Dichloropropene	BDL	6	BDL	6
219	V	Ethylbenzene	BDL	6	BDL	6
220	V	Bromomethane	BDL	13	BDL	11
221	V	Chloromethane	BDL	13	BDL	11
222	V	Methylene chloride	18 B	14 B	14 B	10 B
223	V	1,1,2,2-Tetrachloroethane	BDL	6	BDL	6
224	V	Tetrachloroethene	BDL	6	BDL	6
225	V	Toluene	5 J	4 J	11	BDL
227	V	1,1,1-Trichloroethane	BDL	6	BDL	6
228	V	1,1,2-Trichloroethane	BDL	6	BDL	6
229	V	Trichloroethene	30	69	87	BDL
231	V	Vinyl chloride	BDL	13	BDL	11
250	V	Trans-1,3-Dichloropropene	BDL	6	BDL	6
251	V	Styrene	BDL	6	BDL	6
252	V	Acetone	17 B	18 B	15 B	26 B
253	V	2-Butanone	BDL	13	BDL	11
254	V	Carbon disulfide	BDL	6	BDL	6
255	V	2-Hexanone	BDL	13	BDL	11
256	V	4-Methyl-2-pentanone	BDL	13	BDL	11
257	V	Vinyl acetate	BDL	13	BDL	11
289	V	Xylenes (Total)	BDL	6	BDL	6
299	V	1,2-Dichloroethene (Total)	18	1 J	BDL	6

COLLIERVILLE SITE R/FS:PHASE 1 SOIL BORINGS ANALYTICAL SUMMARY

LAB SAMPLE ID DATE DEPTH MATRIX UNITS CMP CL COMPOUND				Boring 39							
				B39-1		B39-2		B39-3		B39-4	
				01/21/90		01/21/90		01/21/90		01/21/90	
				8		16		24		34	
				SOIL		SOIL		SOIL		SOIL	
				mg/kg		mg/kg		mg/kg		mg/kg	
				ug/kg		ug/kg		ug/kg		ug/kg	
401	B	Acenaphthene		BDL	410	BDL	400	BDL	370	BDL	350
402	B	Acenaphthylene		BDL	410	BDL	400	BDL	370	BDL	350
403	B	Anthracene		BDL	410	BDL	400	BDL	370	BDL	350
405	B	Benzo(a)anthracene		BDL	410	BDL	400	BDL	370	BDL	350
406	B	Benzo(a)pyrene		BDL	410	BDL	400	BDL	370	BDL	350
407	B	Benzo(b)fluoranthene		BDL	410	BDL	400	BDL	370	BDL	350
408	B	Benzo(g,h,i)perylene		BDL	410	BDL	400	BDL	370	BDL	350
409	B	Benzo(k)fluoranthene		BDL	410	BDL	400	BDL	370	BDL	350
410	B	bis(2-Chloroethoxy)methane		BDL	410	BDL	400	BDL	370	BDL	350
411	B	bis(2-Chloroethyl)ether		BDL	410	BDL	400	BDL	370	BDL	350
412	B	bis(2-Chloroisopropyl)ether		BDL	410	BDL	400	BDL	370	BDL	350
413	B	bis(2-Ethylhexyl)phthalate		98 J		BDL	400	BDL	370	180 J	
414	B	4-Bromophenyl phenyl ether		BDL	410	BDL	400	BDL	370	BDL	350
415	B	Butyl benzyl phthalate		BDL	410	BDL	400	BDL	370	BDL	350
416	B	2-Chloronaphthalene		BDL	410	BDL	400	BDL	370	BDL	350
417	B	4-Chlorophenyl phenyl ether		BDL	410	BDL	400	BDL	370	BDL	350
418	B	Chrysene		BDL	410	BDL	400	BDL	370	BDL	350
419	B	Dibenzo(a,h)anthracene		BDL	410	BDL	400	BDL	370	BDL	350
420	B	1,2-Dichlorobenzene		BDL	410	BDL	400	BDL	370	BDL	350
421	B	1,3-Dichlorobenzene		BDL	410	BDL	400	BDL	370	BDL	350
422	B	1,4-Dichlorobenzene		BDL	410	BDL	400	BDL	370	BDL	350
423	B	3,3'-Dichlorobenzidine		BDL	820	BDL	790	BDL	740	BDL	690
424	B	Diethyl phthalate		BDL	410	BDL	400	BDL	370	BDL	350
425	B	Dimethyl phthalate		BDL	410	BDL	400	BDL	370	BDL	350
426	B	Di-n-butyl phthalate		BDL	410	BDL	400	BDL	370	BDL	350
427	B	2,4-Dinitrotoluene		BDL	410	BDL	400	BDL	370	BDL	350
428	B	2,6-Dinitrotoluene		BDL	410	BDL	400	BDL	370	BDL	350
429	B	Di-n-octyl phthalate		BDL	410	BDL	400	BDL	370	BDL	350
431	B	Fluoranthene		BDL	410	BDL	400	BDL	370	BDL	350
432	B	Fluorene		BDL	410	BDL	400	BDL	370	BDL	350
433	B	Hexachlorobenzene		BDL	410	BDL	400	BDL	370	BDL	350
434	B	Hexachlorobutadiene		BDL	410	BDL	400	BDL	370	BDL	350
435	B	Hexachlorocyclopentadiene		BDL	410	BDL	400	BDL	370	BDL	350
436	B	Hexachloroethane		BDL	410	BDL	400	BDL	370	BDL	350
437	B	Indeno(1,2,3-cd)pyrene		BDL	410	BDL	400	BDL	370	BDL	350
438	B	Isophorone		BDL	410	BDL	400	BDL	370	BDL	350
439	B	Naphthalene		BDL	410	BDL	400	BDL	370	BDL	350
440	B	Nitrobenzene		BDL	410	BDL	400	BDL	370	BDL	350
442	B	N-Nitroso-di-n-propylamine		BDL	410	BDL	400	BDL	370	BDL	350
443	B	N-Nitrosodiphenylamine(1)		BDL	410	BDL	400	BDL	370	BDL	350
444	B	Phenanthrene		BDL	410	BDL	400	BDL	370	BDL	350
445	B	Pyrene		BDL	410	BDL	400	BDL	370	BDL	350
446	B	1,2,4-Trichlorobenzene		BDL	410	BDL	400	BDL	370	BDL	350
474	B	Benzyl alcohol		BDL	410	BDL	400	BDL	370	BDL	350
475	B	4-Chloroaniline		BDL	410	BDL	400	BDL	370	BDL	350
476	B	Dibenzofuran		BDL	410	BDL	400	BDL	370	BDL	350
477	B	2-Methylnaphthalene		BDL	410	BDL	400	BDL	370	BDL	350
478	B	2-Nitroaniline		BDL	2000	BDL	1900	BDL	1800	BDL	1700
479	B	3-Nitroaniline		BDL	2000	BDL	1900	BDL	1800	BDL	1700
480	B	4-Nitroaniline		BDL	2000	BDL	1900	BDL	1800	BDL	1700
601	A	2-Chlorophenol		BDL	410	BDL	400	BDL	370	BDL	350
602	A	2,4-Dichlorophenol		BDL	410	BDL	400	BDL	370	BDL	350
603	A	2,4-Dimethylphenol		BDL	410	BDL	400	BDL	370	BDL	350
604	A	4,6-Dinitro-2-methylphenol		BDL	2000	BDL	1900	BDL	1800	BDL	1700
605	A	2,4-Dinitrophenol		BDL	2000	BDL	1900	BDL	1800	BDL	1700
606	A	2-Nitrophenol		BDL	410	BDL	400	BDL	370	BDL	350

COLLIERVILLE SITE RI/FS:PHASE 1 SOIL BORINGS ANALYTICAL SUMMARY

LAB SAMPLE ID DATE DEPTH MATRIX UNITS				Boring 39							
				B39-1		B39-2		B39-3		B39-4	
				01/21/90		01/21/90		01/21/90		01/21/90	
				8		18		24		34	
CMP	CL	COMPOUND	UNITS	SOIL	ug/kg	SOIL	ug/kg	SOIL	ug/kg	SOIL	ug/kg
607	A	4-Nitrophenol		BDL	2000	BDL	1900	BDL	1800	BDL	1700
608	A	4-Chloro-3-methylphenol		BDL	410	BDL	400	BDL	370	BDL	350
609	A	Pentachlorophenol		BDL	2000	BDL	1900	BDL	1800	BDL	1700
610	A	Phenol		BDL	410	BDL	400	BDL	370	BDL	350
611	A	2,4,6-Trichlorophenol		BDL	410	BDL	400	BDL	370	BDL	350
620	A	2-Methylphenol		BDL	410	BDL	400	BDL	370	BDL	350
622	A	4-Methylphenol		BDL	410	BDL	400	BDL	370	BDL	350
625	A	Benzoic acid		BDL	2000	BDL	1900	BDL	1800	BDL	1700
628	A	2,4,5-Trichlorophenol		BDL	2000	BDL	1900	BDL	1800	BDL	1700
701	P	Aldrin		BDL	11	BDL	9.8	BDL	9	BDL	8.4
702	P	Alpha-BHC		BDL	11	BDL	9.8	BDL	9	BDL	8.4
703	P	Beta-BHC		BDL	11	BDL	9.8	BDL	9	BDL	8.4
704	P	Gamma-BHC (Lindane)		BDL	11	BDL	9.8	BDL	9	BDL	8.4
705	P	Delta-BHC		BDL	11	BDL	9.8	BDL	9	BDL	8.4
707	P	4,4'-DDT		BDL	22	BDL	19	BDL	18	BDL	17
708	P	4,4'-DDE		BDL	22	BDL	19	BDL	18	BDL	17
709	P	4,4'-DDD		BDL	22	BDL	19	BDL	18	BDL	17
710	P	Dieldrin		BDL	22	BDL	19	BDL	18	BDL	17
711	P	Endosulfan I		BDL	11	BDL	9.8	BDL	9	BDL	8.4
712	P	Endosulfan II		BDL	22	BDL	19	BDL	18	BDL	17
713	P	Endosulfan sulfate		BDL	22	BDL	19	BDL	18	BDL	17
714	P	Endrin		BDL	22	BDL	19	BDL	18	BDL	17
716	P	Heptachlor		BDL	11	BDL	9.8	BDL	9	BDL	8.4
717	P	Heptachlor epoxide		BDL	11	BDL	9.8	BDL	9	BDL	8.4
718	P	PCB-1242		BDL	110	BDL	96	BDL	90	BDL	84
719	P	PCB-1254		BDL	220	BDL	190	BDL	180	BDL	170
720	P	PCB-1221		BDL	110	BDL	96	BDL	90	BDL	84
721	P	PCB-1232		BDL	110	BDL	96	BDL	90	BDL	84
722	P	PCB-1248		BDL	110	BDL	96	BDL	90	BDL	84
723	P	PCB-1260		BDL	220	BDL	190	BDL	180	BDL	170
724	P	PCB-1016		BDL	110	BDL	96	BDL	90	BDL	84
725	P	Toxaphene		BDL	220	BDL	190	BDL	180	BDL	170
728	P	p,p'-Methoxychlor		BDL	110	BDL	96	BDL	90	BDL	84
739	P	Endrin ketone		BDL	22	BDL	19	BDL	18	BDL	17
747	P	Alpha chlordane		BDL	110	BDL	96	BDL	90	BDL	84
748	P	Gamma chlordane		BDL	110	BDL	96	BDL	90	BDL	84
1001	C	Cyanide		BDL	0.62	BDL	0.6	BDL	0.56	BDL	0.53
1047	C	pH			5.8		6.5		6.9		7.5
1080	C	Percent Solids			80		83		88.6		94.6
1082	C	% Moisture, Undecanted			27		17		11		5

COLLIERVILLE SITE RI/FS:PHASE 1 SOIL BORINGS ANALYTICAL SUMMARY

LAB SAMPLE ID DATE DEPTH MATRIX CMP CL COMPOUND UNITS			Boring 39		Boring 40	
			B39-5	B39-6	B40-1	B40-2
			01/21/90	01/21/90	01/22/90	01/22/90
			40	48	8	18
			SOIL	SOIL	SOIL	SOIL
			mg/kg	mg/kg	mg/kg	mg/kg
101	M	Antimony	BDL	4.4	BDL	5.2
102	M	Arsenic	0.87 B F N	0.77 B F W N	4.8 B F	1.8 B F
103	M	Beryllium	BDL	0.21	1.2 B P	0.46 B P
104	M	Cadmium	BDL	1	BDL	1.1
105	M	Chromium	19.1 P *	11.1 P *	23.7 P	16.7 P
106	M	Copper	3.2 B P	1.5 B P	8.5 P	2.1 B P
107	M	Lead	1.5 F N	1.5 F N	7 F	6.1 F
108	M	Mercury	BDL	0.11	BDL	0.12
109	M	Nickel	6.8 B P	BDL	15.4 P	6.5 B P
110	M	Selenium	BDL	0.42	BDL	0.49
111	M	Silver	BDL	0.83	1.2 B P	BDL
112	M	Thallium	BDL	0.42	BDL	0.49
113	M	Zinc	10.8 P *	9.2 P *	33.9 P	11.7 P
114	M	Barium	5.9 B P	5.1 B P	88.8 P	22.7 B P
115	M	Iron	9990 P	4940 P	20800 P	9530 P
116	M	Manganese	47.5 P N *	28.2 P N *	248 P	29 P
117	M	Vanadium	15.7 P	10.8 P	41.8 P E	32.4 P E
118	M	Aluminum	3510 P *	2040 P *	21800 P	20500 P
120	M	Cobalt	1.9 B P	0.95 B P	7.5 B P	1.1 B P
121	M	Magnesium	134 B P	112 B P	2070 P	604 B P
129	M	Calcium	165 B P	114 B P	1350 P	623 B P
130	M	Sodium	BDL	309	BDL	387
131	M	Potassium	BDL	262	BDL	301
UNITS			ug/kg	ug/kg	ug/kg	ug/kg
203	V	Benzene	BDL	5	BDL	6
205	V	Bromoform	BDL	5	BDL	6
206	V	Carbon tetrachloride	BDL	5	BDL	6
207	V	Chlorobenzene	BDL	5	BDL	6
208	V	Dibromochloromethane	BDL	5	BDL	6
209	V	Chloroethane	BDL	11	BDL	12
211	V	Chloroform	BDL	5	BDL	6
212	V	Bromodichloromethane	BDL	5	BDL	6
214	V	1,1-Dichloroethane	BDL	5	BDL	6
215	V	1,2-Dichloroethane	BDL	5	BDL	6
216	V	1,1-Dichloroethene	BDL	5	BDL	6
217	V	1,2-Dichloropropene	BDL	5	BDL	6
218	V	Cis-1,3-Dichloropropene	BDL	5	BDL	6
219	V	Ethylbenzene	BDL	5	BDL	6
220	V	Bromomethane	BDL	11	BDL	12
221	V	Chloromethane	BDL	11	BDL	12
222	V	Methylene chloride	13 B	8 B	50 B	31 B
223	V	1,1,2,2-Tetrachloroethane	BDL	5	BDL	6
224	V	Tetrachloroethene	BDL	5	BDL	6
225	V	Toluene	3 J	BDL	54	BDL
227	V	1,1,1-Trichloroethane	BDL	5	BDL	6
228	V	1,1,2-Trichloroethane	BDL	5	4 J	BDL
229	V	Trichloroethene	5 J	BDL	6 J	BDL
231	V	Vinyl chloride	BDL	11	BDL	12
250	V	Trans-1,3-Dichloropropene	BDL	5	BDL	6
251	V	Styrene	BDL	5	BDL	6
252	V	Acetone	31 B	25 B	43 B	36 B
253	V	2-Butanone	BDL	11	BDL	12
254	V	Carbon disulfide	BDL	5	BDL	6
255	V	2-Hexanone	BDL	11	BDL	12
256	V	4-Methyl-2-pentanone	BDL	11	BDL	12
257	V	Vinyl acetate	BDL	11	BDL	12
289	V	Xylenes (Total)	BDL	5	BDL	6
290	V	1,2-Dichloroethene (Total)	BDL	5	14	BDL

COLLIERVILLE SITE RI/FS:PHASE 1 SOIL BORINGS ANALYTICAL SUMMARY

LAB SAMPLE ID DATE DEPTH MATRIX CMP CL COMPOUND UNITS				Boring 39		Boring 40			
				B39-5	B39-6	B40-1	B40-2		
				01/21/90	01/21/90	01/22/90	01/22/90		
				40	48	8	18		
				SOIL	SOIL	SOIL	SOIL		
				mg/kg	mg/kg	mg/kg	mg/kg		
UNITS				ug/kg	ug/kg	ug/kg	ug/kg		
401	B	Acenaphthene		BDL	350	BDL	410	BDL	370
402	B	Acenaphthylene		BDL	350	BDL	410	BDL	370
403	B	Anthracene		BDL	350	BDL	410	BDL	370
405	B	Benzo(a)anthracene		BDL	350	BDL	410	BDL	370
406	B	Benzo(a)pyrene		BDL	350	BDL	410	BDL	370
407	B	Benzo(b)fluoranthene		BDL	350	BDL	410	BDL	370
408	B	Benzo(g,h,i)perylene		BDL	350	BDL	410	BDL	370
409	B	Benzo(k)fluoranthene		BDL	350	BDL	410	BDL	370
410	B	bis(2-Chloroethoxy)methane		BDL	350	BDL	410	BDL	370
411	B	bis(2-Chloroethyl)ether		BDL	350	BDL	410	BDL	370
412	B	bis(2-Chloroisopropyl)ether		BDL	350	BDL	410	BDL	370
413	B	bis(2-Ethylhexyl)phthalate		38 J	BDL	86 J	68 J		
414	B	4-Bromophenyl phenyl ether		BDL	350	BDL	410	BDL	370
415	B	Butyl benzyl phthalate		BDL	350	BDL	410	BDL	370
416	B	2-Chloronaphthalene		BDL	350	BDL	410	BDL	370
417	B	4-Chlorophenyl phenyl ether		BDL	350	BDL	410	BDL	370
418	B	Chrysene		BDL	350	BDL	410	BDL	370
419	B	Dibenzo(a,h)anthracene		BDL	350	BDL	410	BDL	370
420	B	1,2-Dichlorobenzene		BDL	350	BDL	410	BDL	370
421	B	1,3-Dichlorobenzene		BDL	350	BDL	410	BDL	370
422	B	1,4-Dichlorobenzene		BDL	350	BDL	410	BDL	370
423	B	3,3'-Dichlorobenzidine		BDL	690	BDL	820	BDL	730
424	B	Diethyl phthalate		BDL	350	BDL	410	BDL	370
425	B	Dimethyl phthalate		BDL	350	BDL	410	BDL	370
426	B	Di-n-butyl phthalate		BDL	350	BDL	410	BDL	370
427	B	2,4-Dinitrotoluene		BDL	350	BDL	410	BDL	370
428	B	2,6-Dinitrotoluene		BDL	350	BDL	410	BDL	370
429	B	Di-n-octyl phthalate		BDL	350	BDL	410	BDL	370
431	B	Fluoranthene		BDL	350	BDL	410	BDL	370
432	B	Fluorene		BDL	350	BDL	410	BDL	370
433	B	Hexachlorobenzene		BDL	350	BDL	410	BDL	370
434	B	Hexachlorobutadiene		BDL	350	BDL	410	BDL	370
436	B	Hexachlorocyclopentadiene		BDL	350	BDL	410	BDL	370
438	B	Hexachloroethane		BDL	350	BDL	410	BDL	370
437	B	Indeno(1,2,3-cd)pyrene		BDL	350	BDL	410	BDL	370
438	B	Isophorone		BDL	350	BDL	410	BDL	370
439	B	Naphthalene		BDL	350	BDL	410	BDL	370
440	B	Nitrobenzene		BDL	350	BDL	410	BDL	370
442	B	N-Nitroso-di-n-propylamine		BDL	350	BDL	410	BDL	370
443	B	N-Nitrosodiphenylamine(1)		BDL	350	BDL	410	BDL	370
444	B	Phenanthrene		BDL	350	BDL	410	BDL	370
445	B	Pyrene		BDL	350	BDL	410	BDL	370
446	B	1,2,4-Trichlorobenzene		BDL	350	BDL	410	BDL	370
474	B	Benzyl alcohol		BDL	350	BDL	410	BDL	370
475	B	4-Chloroaniline		BDL	350	BDL	410	BDL	370
476	B	Dibenzofuran		BDL	350	BDL	410	BDL	370
477	B	2-Methylnaphthalene		BDL	350	BDL	410	BDL	370
478	B	2-Nitroaniline		BDL	1700	BDL	2000	BDL	1800
479	B	3-Nitroaniline		BDL	1700	BDL	2000	BDL	1800
480	B	4-Nitroaniline		BDL	1700	BDL	2000	BDL	1800
601	A	2-Chlorophenol		BDL	350	BDL	410	BDL	370
602	A	2,4-Dichlorophenol		BDL	350	BDL	410	BDL	370
603	A	2,4-Dimethylphenol		BDL	350	BDL	410	BDL	370
604	A	4,6-Dinitro-2-methylphenol		BDL	1700	BDL	2000	BDL	1800
605	A	2,4-Dinitrophenol		BDL	1700	BDL	2000	BDL	1800
606	A	2-Nitrophenol		BDL	350	BDL	410	BDL	370

COLLIERVILLE SITE RI/FS:PHASE 1 SOIL BORINGS ANALYTICAL SUMMARY

			Boring 39		Boring 40	
LAB SAMPLE ID			B39-5	B39-6	B40-1	B40-2
DATE			01/21/90	01/21/90	01/22/90	01/22/90
DEPTH			40	48	8	18
MATRIX			SOIL	SOIL	SOIL	SOIL
UNITS			mg/kg	mg/kg	mg/kg	mg/kg
UNITS			ug/kg	ug/kg	ug/kg	ug/kg
807	A	4-Nitrophenol	BDL	1700	BDL	2000
808	A	4-Chloro-3-methylphenol	BDL	350	BDL	410
809	A	Pentachlorophenol	BDL	1700	BDL	2000
810	A	Phenol	BDL	350	BDL	410
811	A	2,4,6-Trichlorophenol	BDL	350	BDL	410
820	A	2-Methylphenol	BDL	350	BDL	410
822	A	4-Methylphenol	BDL	350	BDL	410
825	A	Benzoic acid	BDL	1700	BDL	2000
826	A	2,4,5-Trichlorophenol	BDL	1700	BDL	2000
701	P	Aldrin	BDL	8.4	BDL	9.9
702	P	Alpha-BHC	BDL	8.4	BDL	9.9
703	P	Beta-BHC	BDL	8.4	BDL	9.9
704	P	Gamma-BHC (Lindane)	BDL	8.4	BDL	9.9
705	P	Delta-BHC	BDL	8.4	BDL	9.9
707	P	4,4'-DDT	BDL	17	BDL	20
708	P	4,4'-DDE	BDL	17	BDL	20
709	P	4,4'-DDD	BDL	17	BDL	20
710	P	Dieldrin	BDL	17	BDL	20
711	P	Endosulfan I	BDL	8.4	BDL	9.9
712	P	Endosulfan II	BDL	17	BDL	20
713	P	Endosulfan sulfate	BDL	17	BDL	20
714	P	Endrin	BDL	17	BDL	20
716	P	Heptachlor	BDL	8.4	BDL	9.9
717	P	Heptachlor epoxide	BDL	8.4	BDL	9.9
718	P	PCB-1242	BDL	84	BDL	99
719	P	PCB-1254	BDL	170	BDL	200
720	P	PCB-1221	BDL	84	BDL	99
721	P	PCB-1232	BDL	84	BDL	99
722	P	PCB-1248	BDL	84	BDL	99
723	P	PCB-1260	BDL	170	BDL	200
724	P	PCB-1016	BDL	84	BDL	99
725	P	Toxaphene	BDL	170	BDL	200
726	P	p,p'-Methoxychlor	BDL	84	BDL	99
739	P	Endrin ketone	BDL	17	BDL	20
747	P	Alpha chlordane	BDL	84	BDL	99
748	P	Gamma chlordane	BDL	84	BDL	99
1001	C	Cyanide	BDL	0.53	BDL	0.62
1047	C	pH	7.4	7.3	6.2	6.5
1080	C	Percent Solids	94.4	95.8	81.3	89.7
1082	C	% Moisture, Undecanted	6	4	19	10

COLLIERVILLE SITE RI/FS:PHASE 1 SOIL BORINGS ANALYTICAL SUMMARY

LAB SAMPLE ID DATE DEPTH MATRIX UNITS			Boring 40			
			B40-3	B40-4	B40-5	B40-6
			01/22/90	01/22/90	01/22/90	01/22/90
			24	32	42	48
CMP	CL	COMPOUND	SOIL mg/kg	SOIL mg/kg	SOIL mg/kg	SOIL mg/kg
101	M	Antimony	BDL	4.4	BDL	4.3
102	M	Arsenic	0.91 B F W	1.2 B F	6 F S	BDL
103	M	Beryllium	BDL	0.25 B P	0.77 B P	0.26 B P
104	M	Cadmium	BDL	1	BDL	1
105	M	Chromium	2.8 P	16.1 P	19 P	18.8 P
106	M	Copper	2 B P	BDL	2.4 B P	2.5 B P
107	M	Lead	3.6 F	2.1 F	2.4 F	14.6 F
108	M	Mercury	BDL	0.1	BDL	0.1
109	M	Nickel	BDL	6	10.6 P	17.3 P
110	M	Selenium	BDL	0.43	BDL	0.41
111	M	Silver	BDL	0.83	BDL	0.82
112	M	Thallium	BDL	0.43	BDL	0.41
113	M	Zinc	9.9 P	9.5 P	33.7 P	48.1 P
114	M	Barium	5.5 B P	7.8 B P	6.2 B P	121 P
115	M	Iron	1030 P	7140 P	27700 P	45000 P
116	M	Manganese	2.6 B P	29.8 P	209 P	510 P
117	M	Vanadium	4.6 B P E	12.3 P E	15.7 P E	27 P E
118	M	Aluminum	2720 P	3140 P	2260 P	6130 P
120	M	Cobalt	BDL	0.83	1 B P	8.5 B P
121	M	Magnesium	108 B P	115 B P	159 B P	592 B P
128	M	Calcium	205 B P	138 B P	111 B P	555 B P
130	M	Sodium	BDL	314	BDL	307
131	M	Potassium	BDL	265	BDL	323 B P
UNITS			ug/kg	ug/kg	ug/kg	ug/kg
203	V	Benzene	BDL	5	BDL	5
205	V	Bromoform	BDL	5	BDL	5
206	V	Carbon tetrachloride	BDL	5	BDL	5
207	V	Chlorobenzene	BDL	5	BDL	5
208	V	Dibromochloromethane	BDL	5	BDL	5
209	V	Chloroethane	BDL	11	BDL	10
211	V	Chloroform	BDL	5	BDL	5
212	V	Bromodichloromethane	BDL	5	BDL	5
214	V	1,1-Dichloroethane	BDL	5	BDL	5
215	V	1,2-Dichloroethane	BDL	5	BDL	5
216	V	1,1-Dichloroethene	BDL	5	BDL	5
217	V	1,2-Dichloropropane	BDL	5	BDL	5
218	V	Cis-1,3-Dichloropropene	BDL	5	BDL	5
219	V	Ethylbenzene	BDL	5	BDL	5
220	V	Bromomethane	BDL	11	BDL	10
221	V	Chloromethane	BDL	11	BDL	10
222	V	Methylene chloride	22 B	23 B	22 B	28 B
223	V	1,1,2,2-Tetrachloroethane	BDL	5	BDL	5
224	V	Tetrachloroethene	BDL	5	BDL	5
225	V	Toluene	BDL	5	BDL	5
227	V	1,1,1-Trichloroethane	BDL	5	BDL	5
228	V	1,1,2-Trichloroethane	BDL	5	BDL	5
229	V	Trichloroethene	BDL	5	BDL	5
231	V	Vinyl chloride	BDL	11	BDL	10
250	V	Trans-1,3-Dichloropropene	BDL	5	BDL	5
251	V	Styrene	BDL	5	BDL	5
252	V	Acetone	29 B	33 B	26 B	19 B
253	V	2-Butanone	BDL	11	BDL	10
254	V	Carboq disulfide	BDL	5	BDL	5
255	V	2-Hexanone	BDL	11	BDL	10
256	V	4-Methyl-2-pentanone	BDL	11	BDL	10
257	V	Vinyl acetate	BDL	11	BDL	10
289	V	Xylenes (Total)	BDL	5	BDL	5
299	V	1,2-Dichloroethene(Total)	BDL	5	BDL	5

COLLIERVILLE SITE RI/FS:PHASE 1 SOIL BORINGS ANALYTICAL SUMMARY

			Boring 40							
LAB SAMPLE ID			B40-3		B40-4		B40-5		B40-6	
DATE			01/22/90		01/22/90		01/22/90		01/22/90	
DEPTH			24		32		42		48	
MATRIX			SOIL		SOIL		SOIL		SOIL	
UNITS			mg/kg		mg/kg		mg/kg		mg/kg	
UNITS			ug/kg		ug/kg		ug/kg		ug/kg	
401	B	Acenaphthene	BDL	350	BDL	350	BDL	340	BDL	410
402	B	Acenaphthylene	BDL	350	BDL	350	BDL	340	BDL	410
403	B	Anthracene	BDL	350	BDL	350	BDL	340	BDL	410
405	B	Benzo(a)anthracene	BDL	350	BDL	350	BDL	340	BDL	410
406	B	Benzo(a)pyrene	BDL	350	BDL	350	BDL	340	BDL	410
407	B	Benzo(b)fluoranthene	BDL	350	BDL	350	BDL	340	BDL	410
408	B	Benzo(g,h,i)perylene	BDL	350	BDL	350	BDL	340	BDL	410
409	B	Benzo(k)fluoranthene	BDL	350	BDL	350	BDL	340	BDL	410
410	B	bis(2-Chloroethoxy)methane	BDL	350	BDL	350	BDL	340	BDL	410
411	B	bis(2-Chloroethyl)ether	BDL	350	BDL	350	BDL	340	BDL	410
412	B	bis(2-Chloroisopropyl)ether	BDL	350	BDL	350	BDL	340	BDL	410
413	B	bis(2-Ethylhexyl)phthalate	250 J		54 J		63 J		290 J	
414	B	4-Bromophenyl phenyl ether	BDL	350	BDL	350	BDL	340	BDL	410
415	B	Butyl benzyl phthalate	BDL	350	BDL	350	BDL	340	BDL	410
416	B	2-Chloronaphthalene	BDL	350	BDL	350	BDL	340	BDL	410
417	B	4-Chlorophenyl phenyl ether	BDL	350	BDL	350	BDL	340	BDL	410
418	B	Chrysene	BDL	350	BDL	350	BDL	340	BDL	410
419	B	Dibenzo(a,h)anthracene	BDL	350	BDL	350	BDL	340	BDL	410
420	B	1,2-Dichlorobenzene	BDL	350	BDL	350	BDL	340	BDL	410
421	B	1,3-Dichlorobenzene	BDL	350	BDL	350	BDL	340	BDL	410
422	B	1,4-Dichlorobenzene	BDL	350	BDL	350	BDL	340	BDL	410
423	B	3,3'-Dichlorobenzidine	BDL	690	BDL	710	BDL	690	BDL	820
424	B	Diethyl phthalate	BDL	350	BDL	350	BDL	340	BDL	410
425	B	Dimethyl phthalate	BDL	350	BDL	350	BDL	340	BDL	410
426	B	Di-n-butyl phthalate	BDL	350	BDL	350	BDL	340	BDL	410
427	B	2,4-Dinitrotoluene	BDL	350	BDL	350	BDL	340	BDL	410
428	B	2,6-Dinitrotoluene	BDL	350	BDL	350	BDL	340	BDL	410
429	B	Di-n-octyl phthalate	BDL	350	BDL	350	BDL	340	BDL	410
431	B	Fluoranthene	BDL	350	BDL	350	BDL	340	BDL	410
432	B	Fluorene	BDL	350	BDL	350	BDL	340	BDL	410
433	B	Hexachlorobenzene	BDL	350	BDL	350	BDL	340	BDL	410
434	B	Hexachlorobutadiene	BDL	350	BDL	350	BDL	340	BDL	410
435	B	Hexachlorocyclopentadiene	BDL	350	BDL	350	BDL	340	BDL	410
436	B	Hexachloroethane	BDL	350	BDL	350	BDL	340	BDL	410
437	B	Indeno(1,2,3-cd)pyrene	BDL	350	BDL	350	BDL	340	BDL	410
438	B	Isophorone	BDL	350	BDL	350	BDL	340	BDL	410
439	B	Naphthalene	BDL	350	BDL	350	BDL	340	BDL	410
440	B	Nitrobenzene	BDL	350	BDL	350	BDL	340	BDL	410
442	B	N-Nitroso-di-n-propylamine	BDL	350	BDL	350	BDL	340	BDL	410
443	B	N-Nitrosodiphenylamine(1)	BDL	350	BDL	350	BDL	340	BDL	410
444	B	Phenanthrene	BDL	350	BDL	350	BDL	340	BDL	410
445	B	Pyrene	BDL	350	BDL	350	BDL	340	BDL	410
446	B	1,2,4-Trichlorobenzene	BDL	350	BDL	350	BDL	340	BDL	410
474	B	Benzyl alcohol	BDL	350	BDL	350	BDL	340	BDL	410
475	B	4-Chloroaniline	BDL	350	BDL	350	BDL	340	BDL	410
476	B	Dibenzofuran	BDL	350	BDL	350	BDL	340	BDL	410
477	B	2-Methylnaphthalene	BDL	350	BDL	350	BDL	340	BDL	410
478	B	2-Nitroaniline	BDL	1700	BDL	1700	BDL	1700	BDL	2000
479	B	3-Nitroaniline	BDL	1700	BDL	1700	BDL	1700	BDL	2000
480	B	4-Nitroaniline	BDL	1700	BDL	1700	BDL	1700	BDL	2000
601	A	2-Chlorophenol	BDL	350	BDL	350	BDL	340	BDL	410
602	A	2,4-Dichlorophenol	BDL	350	BDL	350	BDL	340	BDL	410
603	A	2,4-Dimethylphenol	BDL	350	BDL	350	BDL	340	BDL	410
604	A	4,6-Dinitro-2-methylphenol	BDL	1700	BDL	1700	BDL	1700	BDL	2000
605	A	2,4-Dinitrophenol	BDL	1700	BDL	1700	BDL	1700	BDL	2000
606	A	2-Nitrophenol	BDL	350	BDL	350	BDL	340	BDL	410

COLLIERVILLE SITE RI/FS:PHASE 1 SOIL BORINGS ANALYTICAL SUMMARY

				Boring 40							
LAB SAMPLE ID				B40-3		B40-4		B40-5		B40-6	
DATE				01/22/90		01/22/90		01/22/90		01/22/90	
DEPTH				24		32		42		48	
MATRIX				SOIL		SOIL		SOIL		SOIL	
UNITS				mg/kg		mg/kg		mg/kg		mg/kg	
CMP	CL	COMPOUND	UNITS	ug/kg		ug/kg		ug/kg		ug/kg	
807	A	4-Nitrophenol		BDL	1700	BDL	1700	BDL	1700	BDL	2000
808	A	4-Chloro-3-methylphenol		BDL	350	BDL	350	BDL	340	BDL	410
809	A	Pentachlorophenol		BDL	1700	BDL	1700	BDL	1700	BDL	2000
810	A	Phenol		BDL	350	BDL	350	BDL	340	BDL	410
811	A	2,4,6-Trichlorophenol		BDL	350	BDL	350	BDL	340	BDL	410
820	A	2-Methylphenol		BDL	350	BDL	350	BDL	340	BDL	410
822	A	4-Methylphenol		BDL	350	BDL	350	BDL	340	BDL	410
825	A	Benzoic acid		BDL	1700	BDL	1700	BDL	1700	BDL	2000
828	A	2,4,5-Trichlorophenol		BDL	1700	BDL	1700	BDL	1700	BDL	2000
701	P	Aldrin		BDL	8.4	BDL	8.8	BDL	8.3	BDL	9.9
702	P	Alpha-BHC		BDL	8.4	BDL	8.8	BDL	8.3	BDL	9.9
703	P	Beta-BHC		BDL	8.4	BDL	8.8	BDL	8.3	BDL	9.9
704	P	Gamma-BHC (Lindane)		BDL	8.4	BDL	8.8	BDL	8.3	BDL	9.9
705	P	Delta-BHC		BDL	8.4	BDL	8.8	BDL	8.3	BDL	9.9
707	P	4,4'-DDT		BDL	17	BDL	17	BDL	17	BDL	20
708	P	4,4'-DDE		BDL	17	BDL	17	BDL	17	BDL	20
709	P	4,4'-DDD		BDL	17	BDL	17	BDL	17	BDL	20
710	P	Dieldrin		BDL	17	BDL	17	BDL	17	BDL	20
711	P	Endosulfan I		BDL	8.4	BDL	8.8	BDL	8.3	BDL	9.9
712	P	Endosulfan II		BDL	17	BDL	17	BDL	17	BDL	20
713	P	Endosulfan sulfate		BDL	17	BDL	17	BDL	17	BDL	20
714	P	Endrin		BDL	17	BDL	17	BDL	17	BDL	20
716	P	Heptachlor		BDL	8.4	BDL	8.8	BDL	8.3	BDL	9.9
717	P	Heptachlor epoxide		BDL	8.4	BDL	8.8	BDL	8.3	BDL	9.9
718	P	PCB-1242		BDL	84	BDL	88	BDL	83	BDL	99
719	P	PCB-1254		BDL	170	BDL	170	BDL	170	BDL	200
720	P	PCB-1221		BDL	84	BDL	88	BDL	83	BDL	99
721	P	PCB-1232		BDL	84	BDL	88	BDL	83	BDL	99
722	P	PCB-1248		BDL	84	BDL	88	BDL	83	BDL	99
723	P	PCB-1260		BDL	170	BDL	170	BDL	170	BDL	200
724	P	PCB-1016		BDL	84	BDL	88	BDL	83	BDL	99
725	P	Toxaphene		BDL	170	BDL	170	BDL	170	BDL	200
726	P	p,p'-Methoxychlor		BDL	84	BDL	88	BDL	83	BDL	99
739	P	Endrin ketone		BDL	17	BDL	17	BDL	17	BDL	20
747	P	Alpha chlordane		BDL	84	BDL	88	BDL	83	BDL	99
748	P	Gamma chlordane		BDL	84	BDL	88	BDL	83	BDL	99
1001	C	Cyanide		BDL	0.53	BDL	0.54	BDL	0.52	BDL	0.62
1047	C	pH			7.1		7.1		7.5		6.9
1080	C	Percent Solids			95		93.1		96.2		80.9
1082	C	% Moisture, Undecanted			5		7		4		19

COLLIERVILLE SITE RI/FS:PHASE 1 SOIL BORINGS ANALYTICAL SUMMARY

LAB SAMPLE ID DATE DEPTH MATRIX				Trip Blank		Rinsate Samples	
				LAB PURE 01/22/90 0	011790RS 01/18/90 0	012290RS 01/21/90 0	
CMP	CL	COMPOUND	UNITS	WATER ug/kg	WATER ug/kg	WATER ug/kg	
101	M	Antimony			BDL	21	BDL 21
102	M	Arsenic			BDL	3	BDL 3
103	M	Beryllium			1.8 B P	BDL	BDL 1
104	M	Cadmium			BDL	5	BDL 5
105	M	Chromium			BDL	5	BDL 5
106	M	Copper			BDL	4	BDL 4
107	M	Lead			2.3 B F	BDL	BDL 2
108	M	Mercury			BDL	0.2	BDL 0.2
109	M	Nickel			BDL	29	BDL 29
110	M	Selenium			BDL	2	BDL 2
111	M	Silver			BDL	4	BDL 4
112	M	Thallium			BDL	2	BDL 2
113	M	Zinc			4.6 B P	6.1 B P	
114	M	Barium			5.1 B P	3.3 B P	
115	M	Iron			12.9 B P	161 P *	
116	M	Manganese			BDL	1	1.2 B P
117	M	Vanadium			2.7 B P	4.3 B P	
118	M	Aluminum			BDL	16	BDL 16
120	M	Cobalt			5.8 B P	BDL	BDL 3
121	M	Magnesium			59 B P	194 B P	
129	M	Calcium			92.5 B P	BDL	BDL 17
130	M	Sodium			BDL	1490	BDL 1490
131	M	Potassium			BDL	1260	2030 B P
UNITS				ug/kg	ug/kg	ug/kg	
203	V	Benzene		BDL	5	BDL	5
206	V	Bromoform		BDL	5	BDL	5
206	V	Carbon tetrachloride		BDL	5	BDL	5
207	V	Chlorobenzene		BDL	5	BDL	5
208	V	Dibromochloromethane		BDL	5	BDL	5
209	V	Chloroethane		BDL	10	BDL	10
211	V	Chloroform		BDL	5	BDL	5
212	V	Bromodichloromethane		BDL	5	BDL	5
214	V	1,1-Dichloroethane		BDL	5	BDL	5
215	V	1,2-Dichloroethane		BDL	5	BDL	5
216	V	1,1-Dichloroethene		BDL	5	BDL	5
217	V	1,2-Dichloropropene		BDL	5	BDL	5
218	V	Cis-1,3-Dichloropropene		BDL	5	BDL	5
219	V	Ethylbenzene		BDL	5	BDL	5
220	V	Bromomethane		BDL	10	BDL	10
221	V	Chloromethane		BDL	10	BDL	10
222	V	Methylene chloride		2 J	BDL	5	2 B J
223	V	1,1,2,2-Tetrachloroethane		BDL	5	BDL	5
224	V	Tetrachloroethene		BDL	5	BDL	5
225	V	Toluene		BDL	5	BDL	5
227	V	1,1,1-Trichloroethane		BDL	5	BDL	5
228	V	1,1,2-Trichloroethane		BDL	5	BDL	5
229	V	Trichloroethene		BDL	5	BDL	5
231	V	Vinyl chloride		BDL	10	BDL	10
250	V	Trans-1,3-Dichloropropene		BDL	5	BDL	5
251	V	Styrene		BDL	5	BDL	5
252	V	Acetone		BDL	10	BDL	10
253	V	2-Butanone		BDL	10	BDL	10
254	V	Carbox disulfide		BDL	5	BDL	5
255	V	2-Hexanone		BDL	10	BDL	10
256	V	4-Methyl-2-pentanone		BDL	10	BDL	10
257	V	Vinyl acetate		BDL	10	BDL	10
289	V	Xylenes (Total)		BDL	5	BDL	5
299	V	1,2-Dichloroethene(Total)		BDL	5	BDL	5

COLLIERVILLE SITE RI/FS:PHASE 1 SOIL BORINGS ANALYTICAL SUMMARY

LAB SAMPLE ID DATE DEPTH MATRIX				Trip Blank		Rinsate Samples	
				LAB PURE 01/22/90 0	011790RS 01/18/90 0	012290RS 01/21/90 0	
CMP	CL	COMPOUND	UNITS	WATER ug/kg	WATER ug/kg	WATER ug/kg	
				ug/kg	ug/kg	ug/kg	
401	B	Acenaphthene			BDL	10	BDL
402	B	Acenaphthylene			BDL	10	BDL
403	B	Anthracene			BDL	10	BDL
405	B	Benzo(a)anthracene			BDL	10	BDL
406	B	Benzo(a)pyrene			BDL	10	BDL
407	B	Benzo(b)fluoranthene			BDL	10	BDL
408	B	Benzo(g,h,i)perylene			BDL	10	BDL
409	B	Benzo(k)fluoranthene			BDL	10	BDL
410	B	bis(2-Chloroethoxy)methane			BDL	10	BDL
411	B	bis(2-Chloroethyl)ether			BDL	10	BDL
412	B	bis(2-Chloroisopropyl)ether			BDL	10	BDL
413	B	bis(2-Ethylhexyl)phthalate			BDL	10	BDL
414	B	4-Bromophenyl phenyl ether			BDL	10	BDL
415	B	Butyl benzyl phthalate			BDL	10	BDL
416	B	2-Chloronaphthalene			BDL	10	BDL
417	B	4-Chlorophenyl phenyl ether			BDL	10	BDL
418	B	Chrysene			BDL	10	BDL
419	B	Dibenzo(a,h)anthracene			BDL	10	BDL
420	B	1,2-Dichlorobenzene			BDL	10	BDL
421	B	1,3-Dichlorobenzene			BDL	10	BDL
422	B	1,4-Dichlorobenzene			BDL	10	BDL
423	B	3,3'-Dichlorobenzidine			BDL	20	BDL
424	B	Diethyl phthalate			BDL	10	BDL
425	B	Dimethyl phthalate			BDL	10	BDL
426	B	Di-n-butyl phthalate			BDL	10	BDL
427	B	2,4-Dinitrotoluene			BDL	10	BDL
428	B	2,6-Dinitrotoluene			BDL	10	BDL
429	B	Di-n-octyl phthalate			BDL	10	BDL
431	B	Fluoranthene			BDL	10	BDL
432	B	Fluorene			BDL	10	BDL
433	B	Hexachlorobenzene			BDL	10	BDL
434	B	Hexachlorobutadiene			BDL	10	BDL
435	B	Hexachlorocyclopentadiene			BDL	10	BDL
436	B	Hexachloroethane			BDL	10	BDL
437	B	Indeno(1,2,3-cd)pyrene			BDL	10	BDL
438	B	Isophorone			BDL	10	BDL
439	B	Naphthalene			BDL	10	BDL
440	B	Nitrobenzene			BDL	10	BDL
442	B	N-Nitroso-di-n-propylamine			BDL	10	BDL
443	B	N-Nitrosodiphenylamine(1)			BDL	10	BDL
444	B	Phenanthrene			BDL	10	BDL
445	B	Pyrene			BDL	10	BDL
446	B	1,2,4-Trichlorobenzene			BDL	10	BDL
474	B	Benzyl alcohol			BDL	10	BDL
475	B	4-Chloroaniline			BDL	10	BDL
476	B	Dibenzofuran			BDL	10	BDL
477	B	2-Methylnaphthalene			BDL	10	BDL
478	B	2-Nitroaniline			BDL	50	BDL
479	B	3-Nitroaniline			BDL	50	BDL
480	B	4-Nitroaniline			BDL	50	BDL
601	A	2-Chlorophenol			BDL	10	BDL
602	A	2,4-Dichlorophenol			BDL	10	BDL
603	A	2,4-Dimethylphenol			BDL	10	BDL
604	A	4,6-Dinitro-2-methylphenol			BDL	50	BDL
605	A	2,4-Dinitrophenol			BDL	50	BDL
606	A	2-Nitrophenol			BDL	10	BDL

COLLIERVILLE SITE RI/FS:PHASE 1 SOIL BORINGS ANALYTICAL SUMMARY

		Trip Blank		Rinsate Samples	
LAB SAMPLE ID		LAB PURE	011790RS	012290RS	
DATE		01/22/90	01/18/90	01/21/90	
DEPTH		0	0	0	
MATRIX		WATER	WATER	WATER	
CMP	CL COMPOUND	ug/kg	ug/kg	ug/kg	
UNITS		ug/kg	ug/kg	ug/kg	
607	A 4-Nitrophenol		BDL 50	BDL	50
608	A 4-Chloro-3-methylphenol		BDL 10	BDL	10
609	A Pentachlorophenol		BDL 50	BDL	50
610	A Phenol		BDL 10	BDL	10
611	A 2,4,6-Trichlorophenol		BDL 10	BDL	10
620	A 2-Methylphenol		BDL 10	BDL	10
622	A 4-Methylphenol		BDL 10	BDL	10
625	A Benzoic acid		BDL 50	BDL	50
626	A 2,4,5-Trichlorophenol		BDL 50	BDL	50
701	P Aldrin		BDL 0.05	BDL	0.05
702	P Alpha-BHC		BDL 0.05	BDL	0.05
703	P Beta-BHC		BDL 0.05	BDL	0.05
704	P Gamma-BHC (Lindane)		BDL 0.05	BDL	0.05
705	P Delta-BHC		BDL 0.05	BDL	0.05
707	P 4,4'-DDT		BDL 0.1	BDL	0.1
708	P 4,4'-DDE		BDL 0.1	BDL	0.1
709	P 4,4'-DDD		BDL 0.1	BDL	0.1
710	P Dieldrin		BDL 0.1	BDL	0.1
711	P Endosulfan I		BDL 0.05	BDL	0.05
712	P Endosulfan II		BDL 0.1	BDL	0.1
713	P Endosulfan sulfate		BDL 0.1	BDL	0.1
714	P Endrin		BDL 0.1	BDL	0.1
716	P Heptachlor		BDL 0.05	BDL	0.05
717	P Heptachlor epoxide		BDL 0.05	BDL	0.05
718	P PCB-1242		BDL 0.5	BDL	0.5
719	P PCB-1254		BDL 1	BDL	1
720	P PCB-1221		BDL 0.5	BDL	0.5
721	P PCB-1232		BDL 0.5	BDL	0.5
722	P PCB-1248		BDL 0.5	BDL	0.5
723	P PCB-1260		BDL 1	BDL	1
724	P PCB-1016		BDL 0.5	BDL	0.5
725	P Toxaphene		BDL 1	BDL	1
726	P p,p'-Methoxychlor		BDL 0.5	BDL	0.5
739	P Endrin ketone		BDL 0.1	BDL	0.1
747	P Alpha chlordane		BDL 0.5	BDL	0.5
748	P Gamma chlordane		BDL 0.5	BDL	0.5
1001	C Cyanide		BDL 10	BDL	10
1047	C pH				
1080	C Percent Solids				
1082	C % Moisture, Uncalcinated				

APPENDIX C

COLLIERVILLE SITE REMEDIAL INVESTIGATION

PHASE 1 SAMPLING ANALYTICAL RESULTS SUMMARY

GROUND WATER DATA

QUALITY ASSURANCE FLAG LEGEND

- B = ANALYTE FOUND IN BLANK
- BDL = ANALYZED FOR BUT NOT FOUND AT DETECTION LIMIT (SEE ALSO U)
- CV AA (COLD VAPOR) METHOD OF ANALYSIS FOR METALS
- D = COMPOUND ANALYZED FROM A DILUTED SAMPLE
- E = ORGANIC COMPOUNDS: CONCENTRATION EXCEEDS CALIBRATION RANGE
METALS: VALUE ESTIMATED DUE TO INTERFERENCES
- F = AA (FURNACE) METHOD OF ANALYSIS FOR METALS
- J = VALUE ESTIMATED
- N = SPIKE SAMPLE RECOVERY OUTSIDE OF CONTROL LIMITS
- P = ICAP METHOD OF ANALYSIS FOR METALS
- S = VALUE DETERMINED BY METHOD OF STANDARD ADDITIONS
- U = ANALYZED FOR BUT NOT DETECTED
- W = POST DIGESTION AA SPIKE OUTSIDE OF CONTROL LIMITS, AND SAMPLE
ABSORBANCE LESS THAN 50% OF SPIKE ABSORBANCE
- = DEVIATION BETWEEN DUPLICATE INORGANIC ANALYSES GREATER THAN
CLP SOW GUIDELINES
- + = STANDARD ADDITIONS CORRELATION COEFFICIENT LESS THAN 0.995

COLLIERVILLE SITE REMEDIAL INVESTIGATION: PHASE 1 GROUND WATER ANALYSIS SUMMARY

POINT SAMPLE			MW01	MW1B				MW03	MW04
CMPO-DESC			12218901	1221891BM	1221891BD	1221891B	12198903	12218904	
CMP	CL		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	
101	M	Antimony	21 U	21 U	21 U	21 U	21 U	21 U	
102	M	Arsenic	3 UW	3 UW	3 U	3 U	3 U	3 UW	
103	M	Beryllium	1 U	1 U	1.1 B	1 U	1 U	1 U	
104	M	Cadmium	5 U	5 U	5 U	5 U	5 U	5 U	
105	M	Chromium	5 U	5 U	5 U	5 U	5 U	5 U	
106	M	Copper	4 U	4 U	18.2 B	8.2 B	27	29.3	
107	M	Lead	2 U	2 BW	2 UW	2 UW	106	11.9 W	
108	M	Mercury	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	
109	M	Nickel	29 U	29 U	29 U	29 U	29 U	29 U	
110	M	Selenium	10 UN	10 UN	10 UWN	10 UN	10 UWN	10 UWN	
111	M	Silver	4 U	6.3 U	4 U	4 U	4 U	4 U	
112	M	Thallium	2 U	2 U	2 U	2 U	2 UW	2 UW	
113	M	Zinc	2.2 B	5410	4890	5020	21900	5540	
114	M	Barium	26.3 B	131 B	147 B	154 B	86.7 B	52.6 B	
115	M	Iron	20.1 B	1220	1090	1030	8290	1540	
116	M	Manganese	7.7 B	302	349	372	667	48.5	
117	M	Vanadium	3.9 B	4.8 B	2 U	7.3 B	6.6 B	8.5 B	
118	M	Aluminum	22.3 B	494	84.6 B	200 B	1220	845	
120	M	Cobalt	3 U	3.5 B	9.5 B	7.5 B	13 B	4.5 B	
121	M	Magnesium	2040 BE	2090 BE	2320 BE	2290 BE	6440 E	4640 BE	
129	M	Calcium	4990 B	8110	8270	8280	48900	40000	
130	M	Sodium	19300	21000	23900	23000	22400	31100	
131	M	Potassium	3040 B	2660 B	4750 B	3110 B	4170 B	4610 B	
201	V	Acrolein	10 U				100 U		
202	V	Acrylonitrile	10 U				100 U		
203	V	Benzene	25 U	31 U	28 U	28 U	140 U	5 U	
205	V	Bromoform	25 U	31 U	28 U	28 U	140 U	5 U	
206	V	Carbon tetrachloride	25 U	31 U	28 U	28 U	140 U	5 U	
207	V	Chlorobenzene	25 U	31 U	28 U	28 U	140 U	5 U	
208	V	Dibromochloromethane	25 U	31 U	28 U	28 U	140 U	5 U	
209	V	Chloroethane	50 U	63 U	56 U	56 U	280 U	10 U	
210	V	2-Chloroethyl vinyl ether							
211	V	Chloroform	25 U	31 U	28 U	28 U	140 U	5 U	
212	V	Bromodichloromethane	25 U	31 U	28 U	28 U	140 U	5 U	
214	V	1,1-Dichloroethane	25 U	31 U	28 U	28 U	140 U	5 U	
215	V	1,2-Dichloroethane	25 U	31 U	28 U	28 U	140 U	5 U	
216	V	1,1-Dichloroethene	25 U	31 U	28 U	28 U	140 U	5 U	
217	V	1,2-Dichloropropane	25 U	31 U	28 U	28 U	140 U	5 U	
218	V	Cis-1,3-Dichloropropene	25 U	31 U	28 U	28 U	140 U	5 U	
219	V	Ethylbenzene	25 U	31 U	28 U	28 U	140 U	5 U	
220	V	Bromomethane	50 U	63 U	56 U	56 U	280 U	10 U	
221	V	Chloromethane	50 U	63 U	56 U	56 U	280 U	10 U	
222	V	Methylene chloride	25 U	31 U	28 U	28 U	140 U	5 U	
223	V	1,1,2,2-Tetrachloroethane	25 U	31 U	28 U	28 U	140 U	5 U	
224	V	Tetrachloroethene	25 U	31 U	28 U	28 U	140 U	5 U	
225	V	Toluene	25 U	31 U	9 J	28 U	140 U	2 J	
227	V	1,1,1-Trichloroethane	25 U	31 U	22 J	28 U	140 U	5 U	
228	V	1,1,2-Trichloroethane	25 U	31 U	28 U	28 U	140 U	5 U	
229	V	Trichloroethene	680	880	880	1100	4400	85	
231	V	Vinyl chloride	50 U	63 U	56 U	56 U	280 U	10 U	
230	V	Trans-1,3-Dichloropropene	25 U	31 U	28 U	28 U	140 U	5 U	
251	V	Styrene	25 U	31 U	28 U	28 U	140 U	5 U	
252	V	Acetone	50 U	63 U	56 U	56 U	2800	10 U	
253	V	2-Butanone	50 U	63 U	56 U	56 U	280 U	10 U	
254	V	Carbon disulfide	25 U	31 U	28 U	28 U	140 U	5 U	
255	V	2-Hexanone	50 U	63 U	56 U	56 U	280 U	10 U	
256	V	4-Methyl-2-pentanone	50 U	63 U	56 U	56 U	280 U	10 U	
257	V	Vinyl acetate	50 U	63 U	56 U	56 U	280 U	10 U	
289	V	Xylenes (Total)	25 U	31 U	28 U	28 U	140 U	5 U	
299	V	1,2-Dichloroethene (Total)	62	190	250	250	5300	9	
401	B	Acenaphthene	10 U	10 U	10 U	10 U		10 U	
402	B	Acenaphthylene	10 U	10 U	10 U	10 U		10 U	
403	B	Anthracene	10 U	10 U	10 U	10 U		10 U	

COLLIERVILLE SITE REMEDIAL INVESTIGATION: PHASE 1 GROUND WATER ANALYSIS SUMMARY

		POINT	MW01	MW1B		MW03	MW04
		SAMPLE	12218901	12218918M	12218918D	12218918	12218904
CMP	CL	CMPO-DESC	ug/L	ug/L	ug/L	ug/L	ug/L
405	B	Benzo(a)anthracene	10 U	10 U	10 U	10 U	10 U
406	B	Benzo(a)pyrene	10 U	10 U	10 U	10 U	10 U
407	B	Benzo(b)fluoranthene	10 U	10 U	10 U	10 U	10 U
408	B	Benzo(g,h,i)perylene	10 U	10 U	10 U	10 U	10 U
409	B	Benzo(k)fluoranthene	10 U	10 U	10 U	10 U	10 U
410	B	bis(2-Chloroethoxy)methane	10 U	10 U	10 U	10 U	10 U
411	B	bis(2-Chloroethyl)ether	10 U	10 U	10 U	10 U	10 U
412	B	bis(2-Chloroisopropyl)ether	10 U	10 U	10 U	10 U	10 U
413	B	bis(2-Ethylhexyl)phthalate	10 U	10 U	10 U	10 U	10 U
414	B	4-Bromophenyl phenyl ether	10 U	10 U	10 U	10 U	10 U
415	B	Butyl benzyl phthalate	10 U	10 U	10 U	10 U	10 U
416	B	2-Chloronaphthalene	10 U	10 U	10 U	10 U	10 U
417	B	4-Chlorophenyl phenyl ether	10 U	10 U	10 U	10 U	10 U
418	B	Chrysene	10 U	10 U	10 U	10 U	10 U
419	B	Dibenzo(a,h)anthracene	10 U	10 U	10 U	10 U	10 U
420	B	1,2-Dichlorobenzene	10 U	10 U	10 U	10 U	10 U
421	B	1,3-Dichlorobenzene	10 U	10 U	10 U	10 U	10 U
422	B	1,4-Dichlorobenzene	10 U	10 U	10 U	10 U	10 U
423	B	3,3'-Dichlorobenzidine	20 U	20 U	20 U	20 U	20 U
424	B	Diethyl phthalate	10 U	10 U	10 U	10 U	10 U
425	B	Dimethyl phthalate	10 U	10 U	10 U	10 U	10 U
426	B	Di-n-butyl phthalate	10 U	10 U	10 U	10 U	10 U
427	B	2,4-Dinitrotoluene	10 U	10 U	10 U	10 U	10 U
428	B	2,6-Dinitrotoluene	10 U	10 U	10 U	10 U	10 U
429	B	Di-n-octyl phthalate	10 U	10 U	10 U	10 U	10 U
431	B	Fluoranthene	10 U	10 U	10 U	10 U	10 U
432	B	Fluorene	10 U	10 U	10 U	10 U	10 U
433	B	Hexachlorobenzene	10 U	10 U	10 U	10 U	10 U
434	B	Hexachlorobutadiene	10 U	10 U	10 U	10 U	10 U
435	B	Hexachlorocyclopentadiene	10 U	10 U	10 U	10 U	10 U
436	B	Hexachloroethane	10 U	10 U	10 U	10 U	10 U
437	B	Indeno(1,2,3-cd)pyrene	10 U	10 U	10 U	10 U	10 U
438	B	Isophorone	10 U	10 U	10 U	10 U	10 U
439	B	Naphthalene	10 U	10 U	10 U	10 U	10 U
440	B	Nitrobenzene	10 U	10 U	10 U	10 U	10 U
442	B	N-Nitroso-di-n-propylamine	10 U	10 U	10 U	10 U	10 U
443	B	N-Nitrosodiphenylamine(1)	10 U	10 U	10 U	10 U	10 U
444	B	Phenanthrene	10 U	10 U	10 U	10 U	10 U
445	B	Pyrene	10 U	10 U	10 U	10 U	10 U
446	B	1,2,4-Trichlorobenzene	10 U	10 U	10 U	10 U	10 U
474	B	Benzyl alcohol	10 U	10 U	10 U	10 U	10 U
475	B	4-Chloroaniline	10 U	10 U	10 U	10 U	10 U
476	B	Dibenzofuran	10 U	10 U	10 U	10 U	10 U
477	B	2-Methylnaphthalene	10 U	10 U	10 U	10 U	10 U
478	B	2-Nitroaniline	50 U	50 U	50 U	50 U	50 U
479	B	3-Nitroaniline	50 U	50 U	50 U	50 U	50 U
480	B	4-Nitroaniline	50 U	50 U	50 U	50 U	50 U
601	A	2-Chlorophenol	10 U	10 U	10 U	10 U	10 U
602	A	2,4-Dichlorophenol	10 U	10 U	10 U	10 U	10 U
603	A	2,4-Dimethylphenol	10 U	10 U	10 U	10 U	10 U
604	A	4,6-Dinitro-2-methylphenol	50 U	50 U	50 U	50 U	50 U
605	A	2,4-Dinitrophenol	50 U	50 U	50 U	50 U	50 U
606	A	2-Nitrophenol	10 U	10 U	10 U	10 U	10 U
607	A	4-Nitrophenol	50 U	50 U	50 U	50 U	50 U
608	A	4-Chloro-3-methylphenol	10 U	10 U	10 U	10 U	10 U
609	A	Pentachlorophenol	50 U	50 U	50 U	50 U	50 U
610	A	Phenol	10 U	10 U	10 U	10 U	10 U
611	A	2,4,6-Trichlorophenol	10 U	10 U	10 U	10 U	10 U
620	A	2-Methylphenol	10 U	10 U	10 U	10 U	10 U
622	A	4-Methylphenol	10 U	10 U	10 U	10 U	10 U
625	A	Benzoic acid	50 U	50 U	50 U	50 U	50 U
626	A	2,4,5-Trichlorophenol	50 U	50 U	50 U	50 U	50 U

COLLIERVILLE SITE REMEDIAL INVESTIGATION: PHASE 1 GROUND WATER ANALYSIS SUMMARY

CMP	CL	POINT SAMPLE CMPD-DESC	MW01	MW1B			MW03	MW04
			12218901 ug/L	1221891BM ug/L	1221891BD ug/L	1221891B ug/L	12188903 ug/L	12218904 ug/L
701	P	Aldrin	0.05 U	0.05 U	0.05 U	0.05 U		0.05 U
702	P	Alpha-BHC	0.05 U	0.05 U	0.05 U	0.05 U		0.05 U
703	P	Beta-BHC	0.05 U	0.05 U	0.05 U	0.05 U		0.05 U
704	P	Gamma-BHC (Lindane)	0.05 U	0.05 U	0.05 U	0.05 U		0.05 U
705	P	Delta-BHC	0.05 U	0.05 U	0.05 U	0.05 U		0.05 U
707	P	4,4'-DDT	0.1 U	0.1 U	0.1 U	0.1 U		0.1 U
708	P	4,4'-DDE	0.1 U	0.1 U	0.1 U	0.1 U		0.1 U
709	P	4,4'-DDD	0.1 U	0.1 U	0.1 U	0.1 U		0.1 U
710	P	Dieldrin	0.1 U	0.1 U	0.1 U	0.1 U		0.1 U
711	P	Endosulfan I	0.05 U	0.05 U	0.05 U	0.05 U		0.05 U
712	P	Endosulfan II	0.1 U	0.1 U	0.1 U	0.1 U		0.1 U
713	P	Endosulfan sulfate	0.1 U	0.1 U	0.1 U	0.1 U		0.1 U
714	P	Endrin	0.1 U	0.1 U	0.1 U	0.1 U		0.1 U
716	P	Heptachlor	0.05 U	0.05 U	0.05 U	0.05 U		0.05 U
717	P	Heptachlor epoxide	0.05 U	0.05 U	0.05 U	0.05 U		0.05 U
718	P	PCB-1242	0.5 U	0.5 U	0.5 U	0.5 U		0.5 U
719	P	PCB-1254	1 U	1 U	1 U	1 U		1 U
720	P	PCB-1221	0.5 U	0.5 U	0.5 U	0.5 U		0.5 U
721	P	PCB-1232	0.5 U	0.5 U	0.5 U	0.5 U		0.5 U
722	P	PCB-1248	0.5 U	0.5 U	0.5 U	0.5 U		0.5 U
723	P	PCB-1260	1 U	1 U	1 U	1 U		1 U
724	P	PCB-1016	0.5 U	0.5 U	0.5 U	0.5 U		0.5 U
725	P	Toxaphene	1 U	1 U	1 U	1 U		1 U
726	P	p,p'-Methoxychlor	0.5 U	0.5 U	0.5 U	0.5 U		0.5 U
739	P	Endrin ketone	0.1 U	0.1 U	0.1 U	0.1 U		0.1 U
747	P	Alpha chlordane	0.5 U	0.5 U	0.5 U	0.5 U		0.5 U
748	P	Gamma chlordane	0.5 U	0.5 U	0.5 U	0.5 U		0.5 U
1001	C	Cyanide	10 U AS	10 U AS	10 U AS	10 U AS		10 U AS

COLLIERVILLE SITE REMEDIAL INVESTIGATION: PHASE 1 GROUND WATER ANALYSIS SUMMARY

CMP	CL	POINT SAMPLE CMPD-DESC	MW05	MW06	MW10	MW12	MW13	MW14
			12188905 ug/L	12218906 ug/L	12218910 ug/L	12228912 ug/L	12228913 ug/L	12228914 ug/L
101	M	Antimony	21 U	21 U	21 U	21 U	21 U	21 U
102	M	Arsenic	3 U	3 U	3 U	3 UW	3 U	3 UW
103	M	Beryllium	1.3 B	1 U	1 U	1 U	3.9 B	1 U
104	M	Cadmium	5 U	5 U	5 U	5 U	5.6	5 U
105	M	Chromium	5 U	5 U	5 U	11.7	5 U	5 U
106	M	Copper	4 U	25.5	4 U	4 U	6.4 B	4 U
107	M	Lead	4 W	2 UW	2 U	2 UW	2 U	2 UW
108	M	Mercury	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
109	M	Nickel	29 U	29 U	29 U	29 U	29 U	29 U
110	M	Selenium	10 UWN	10 UWN	10 UN	2 UWN	10 UN	10 UN
111	M	Silver	4 U	4 U	4 U	4 U	4 U	4 U
112	M	Thallium	2 UW	2 U	2 UW	2 U	2 UW	2 UW
113	M	Zinc	4220	3020	13.8 B	4.5 B	15.9 B	5.9 B
114	M	Barium	124 B	39.2 B	36.7 B	27.4 B	57.5 B	30.2 B
115	M	Iron	1260	990	4.7 B	185	20.2 B	170
116	M	Manganese	281	33.8	8.5 B	6.7 B	11.3 B	1.7 B
117	M	Vanadium	2 U	6.8 B	5.7 B	4.3 B	5 B	2 U
118	M	Aluminum	309	89.7 B	16 U	18.8 U	16 U	16 U
120	M	Cobalt	7.1 B	4.8 B	3 U	3 U	3.8 B	3 U
121	M	Magnesium	6800 E	2740 BE	3730 BE	2750 BE	2300 BE	2700 B
129	M	Calcium	32000	7240	13500	7090	5670	7230
130	M	Sodium	106000	19300	27900	15200	63000	22900
131	M	Potassium	2790 B	2720 B	5480	2320 B	2260 B	2500 BE
201	V	Acrolein						
202	V	Acrylonitrile						
203	V	Benzene	140 U	5 U	5 U	5 U	5 U	5 U
205	V	Bromoform	140 U	5 U	5 U	5 U	5 U	5 U
206	V	Carbon tetrachloride	140 U	5 U	5 U	5 U	5 U	5 U
207	V	Chlorobenzene	140 U	5 U	5 U	5 U	5 U	5 U
208	V	Dibromochloromethane	140 U	5 U	5 U	5 U	5 U	5 U
209	V	Chloroethane	280 U	10 U	10 U	10 U	10 U	10 U
210	V	2-Chloroethyl vinyl ether						
211	V	Chloroform	1 J	5 U	5 U	5 U	5 U	5 U
212	V	Bromodichloromethane	140 U	5 U	5 U	5 U	5 U	5 U
214	V	1,1-Dichloroethane	140 U	5 U	5 U	5 U	5 U	5 U
215	V	1,2-Dichloroethane	140 U	5 U	5 U	5 U	5 U	5 U
216	V	1,1-Dichloroethene	6	5 U	5 U	5 U	5 U	5 U
217	V	1,2-Dichloropropane	140 U	5 U	5 U	5 U	5 U	5 U
218	V	Cis-1,3-Dichloropropene	140 U	5 U	5 U	5 U	5 U	5 U
219	V	Ethylbenzene	140 U	5 U	5 U	5 U	5 U	5 U
220	V	Bromomethane	280 U	10 U	10 U	10 U	10 U	10 U
221	V	Chloromethane	280 U	10 U	10 U	10 U	10 U	10 U
222	V	Methylene chloride	140 U	5 U	5 U	5 U	5 U	5 U
223	V	1,1,2,2-Tetrachloroethane	140 U	5 U	5 U	5 U	5 U	5 U
224	V	Tetrachloroethene	140 U	5 U	5 U	5 U	5 U	5 U
225	V	Toluene	140 U	5 U	5 U	5 U	3 J	3 J
227	V	1,1,1-Trichloroethane	140 U	5 U	5 U	5 U	5 U	5 U
228	V	1,1,2-Trichloroethane	140 U	5 U	5 U	5 U	5 U	5 U
229	V	Trichloroethene	4200 D	2 J	3 J	5 U	140	5 U
231	V	Vinyl chloride	280 U	10 U	10 U	10 U	10 U	10 U
250	V	Trans-1,3-Dichloropropene	140 U	5 U	5 U	5 U	5 U	5 U
251	V	Styrene	140 U	5 U	5 U	5 U	5 U	5 U
252	V	Acetone	280 U	10 U	10 U	10 U	10 U	10 U
253	V	2-Butanone	280 U	10 U	10 U	10 U	10 U	10 U
254	V	Carbon disulfide	140 U	5 U	5 U	5 U	5 U	5 U
255	V	2-Hexanone	280 U	10 U	10 U	10 U	10 U	10 U
256	V	4-Methyl-2-pentanone	280 U	10 U	10 U	10 U	10 U	10 U
257	V	Vinyl acetate	280 U	10 U	10 U	10 U	10 U	10 U
289	V	Xylenes (Total)	140 U	5 U	5 U	5 U	5 U	5 U
290	V	1,2-Dichloroethene(Total)	4800 D	5 U	5 U	5 U	5 U	5 U
401	B	Acenaphthene	10 U	10 U	10 U	10 U	10 U	10 U
402	B	Acenaphthylene	10 U	10 U	10 U	10 U	10 U	10 U
403	B	Anthracene	10 U	10 U	10 U	10 U	10 U	10 U

COLLIERVILLE SITE REMEDIAL INVESTIGATION: PHASE 1 GROUND WATER ANALYSIS SUMMARY

		POINT SAMPLE	MW05 12198905	MW06 12218908	MW10 12218910	MW12 12228912	MW13 12228913	MW14 12228914
CMP	CL	CMPD-DESC	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
405	B	Benzo(a)anthracene	10 U	10 U	10 U	10 U	10 U	10 U
406	B	Benzo(a)pyrene	10 U	10 U	10 U	10 U	10 U	10 U
407	B	Benzo(b)fluoranthene	10 U	10 U	10 U	10 U	10 U	10 U
408	B	Benzo(g,h,i)perylene	10 U	10 U	10 U	10 U	10 U	10 U
409	B	Benzo(k)fluoranthene	10 U	10 U	10 U	10 U	10 U	10 U
410	B	bis(2-Chloroethoxy)methane	10 U	10 U	10 U	10 U	10 U	10 U
411	B	bis(2-Chloroethyl)ether	10 U	10 U	10 U	10 U	10 U	10 U
412	B	bis(2-Chloroisopropyl)ether	10 U	10 U	10 U	10 U	10 U	10 U
413	B	bis(2-Ethylhexyl)phthalate	2 J	10 U	10 U	10 U	10 U	10 U
414	B	4-Bromophenyl phenyl ether	10 U	10 U	10 U	10 U	10 U	10 U
415	B	Butyl benzyl phthalate	10 U	10 U	10 U	10 U	10 U	10 U
416	B	2-Chloronaphthalene	10 U	10 U	10 U	10 U	10 U	10 U
417	B	4-Chlorophenyl phenyl ether	10 U	10 U	10 U	10 U	10 U	10 U
418	B	Chrysene	10 U	10 U	10 U	10 U	10 U	10 U
419	B	Dibenzo(a,h)anthracene	10 U	10 U	10 U	10 U	10 U	10 U
420	B	1,2-Dichlorobenzene	10 U	10 U	10 U	10 U	10 U	10 U
421	B	1,3-Dichlorobenzene	10 U	10 U	10 U	10 U	10 U	10 U
422	B	1,4-Dichlorobenzene	10 U	10 U	10 U	10 U	10 U	10 U
423	B	3,3'-Dichlorobenzidine	20 U	20 U	20 U	20 U	20 U	20 U
424	B	Diethyl phthalate	10 U	10 U	10 U	10 U	10 U	10 U
425	B	Dimethyl phthalate	10 U	10 U	10 U	10 U	10 U	10 U
426	B	Di-n-butyl phthalate	10 U	10 U	10 U	10 U	10 U	10 U
427	B	2,4-Dinitrotoluene	10 U	10 U	10 U	10 U	10 U	10 U
428	B	2,6-Dinitrotoluene	10 U	10 U	10 U	10 U	10 U	10 U
429	B	Di-n-octyl phthalate	10 U	10 U	10 U	10 U	10 U	10 U
431	B	Fluoranthene	10 U	10 U	10 U	10 U	10 U	10 U
432	B	Fluorene	10 U	10 U	10 U	10 U	10 U	10 U
433	B	Hexachlorobenzene	10 U	10 U	10 U	10 U	10 U	10 U
434	B	Hexachlorobutadiene	10 U	10 U	10 U	10 U	10 U	10 U
435	B	Hexachlorocyclopentadiene	10 U	10 U	10 U	10 U	10 U	10 U
436	B	Hexachloroethane	10 U	10 U	10 U	10 U	10 U	10 U
437	B	Indeno(1,2,3-cd)pyrene	10 U	10 U	10 U	10 U	10 U	10 U
438	B	Isophorone	10 U	10 U	10 U	10 U	10 U	10 U
439	B	Naphthalene	10 U	10 U	10 U	10 U	10 U	10 U
440	B	Nitrobenzene	10 U	10 U	10 U	10 U	10 U	10 U
442	B	N-Nitroso-di-n-propylamine	10 U	10 U	10 U	10 U	10 U	10 U
443	B	N-Nitrosodiphenylamine(1)	10 U	10 U	10 U	10 U	10 U	10 U
444	B	Phenanthrene	10 U	10 U	10 U	10 U	10 U	10 U
445	B	Pyrene	10 U	10 U	10 U	10 U	10 U	10 U
446	B	1,2,4-Trichlorobenzene	10 U	10 U	10 U	10 U	10 U	10 U
474	B	Benzyl alcohol	10 U	10 U	10 U	10 U	10 U	10 U
475	B	4-Chloroaniline	10 U	10 U	10 U	10 U	10 U	10 U
476	B	Dibenzofuran	10 U	10 U	10 U	10 U	10 U	10 U
477	B	2-Methylnaphthalene	10 U	10 U	10 U	10 U	10 U	10 U
478	B	2-Nitroaniline	50 U	50 U	50 U	50 U	50 U	50 U
479	B	3-Nitroaniline	50 U	50 U	50 U	50 U	50 U	50 U
480	B	4-Nitroaniline	50 U	50 U	50 U	50 U	50 U	50 U
601	A	2-Chlorophenol	10 U	10 U	10 U	10 U	10 U	10 U
602	A	2,4-Dichlorophenol	10 U	10 U	10 U	10 U	10 U	10 U
603	A	2,4-Dimethylphenol	10 U	10 U	10 U	10 U	10 U	10 U
604	A	4,6-Dinitro-2-methylphenol	50 U	50 U	50 U	50 U	50 U	50 U
605	A	2,4-Dinitrophenol	50 U	50 U	50 U	50 U	50 U	50 U
606	A	2-Nitrophenol	10 U	10 U	10 U	10 U	10 U	10 U
607	A	4-Nitrophenol	50 U	50 U	50 U	50 U	50 U	50 U
608	A	4-Chloro-3-methylphenol	10 U	10 U	10 U	10 U	10 U	10 U
609	A	Pentachlorophenol	50 U	50 U	50 U	50 U	50 U	50 U
610	A	Phenol	10 U	10 U	10 U	10 U	10 U	10 U
611	A	2,4,6-Trichlorophenol	10 U	10 U	10 U	10 U	10 U	10 U
620	A	2-Methylphenol	10 U	10 U	10 U	10 U	10 U	10 U
622	A	4-Methylphenol	10 U	10 U	10 U	10 U	10 U	10 U
625	A	Benzoic acid	50 U	50 U	50 U	50 U	50 U	50 U
626	A	2,4,5-Trichlorophenol	50 U	50 U	50 U	50 U	50 U	50 U

COLLIERVILLE SITE REMEDIAL INVESTIGATION: PHASE 1 GROUND WATER ANALYSIS SUMMARY

CMP	CL	POINT	MW05	MW06	MW10	MW12	MW13	MW14
		SAMPLE CMPD-DESC	12198905 ug/L	12218906 ug/L	12218910 ug/L	12228912 ug/L	12228913 ug/L	12228914 ug/L
701	P	Aldrin		0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
702	P	Alpha-BHC		0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
703	P	Beta-BHC		0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
704	P	Gamma-BHC (Lindane)		0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
705	P	Delta-BHC		0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
707	P	4,4'-DDT		0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
708	P	4,4'-DDE		0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
709	P	4,4'-DDD		0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
710	P	Dieldrin		0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
711	P	Endosulfan I		0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
712	P	Endosulfan II		0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
713	P	Endosulfan sulfate		0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
714	P	Endrin		0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
716	P	Heptachlor		0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
717	P	Heptachlor epoxide		0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
718	P	PCB-1242		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
719	P	PCB-1254		1 U	1 U	1 U	1 U	1 U
720	P	PCB-1221		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
721	P	PCB-1232		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
722	P	PCB-1248		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
723	P	PCB-1260		1 U	1 U	1 U	1 U	1 U
724	P	PCB-1016		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
725	P	Toxaphene		1 U	1 U	1 U	1 U	1 U
726	P	p,p'-Methoxychlor		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
739	P	Endrin ketone		0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
747	P	Alpha chlordane		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
748	P	Gamma chlordane		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1001	C	Cyanide	10 U AS	10 U AS	10 U AS	10 U AS	10 U AS	10 U AS

CMP CL	POINT SAMPLE CMPD-DESC	MW16 12208918 ug/L	MW21 12208921 ug/L	MW23 12198923 ug/L	WEST CITY WELL 122089WC ug/L	EAST CITY WELL 122089EC ug/L
101 M	Antimony	21 U		21 U	21 U	21 U
102 M	Arsenic	3 U		3 U	3 UW	3 U
103 M	Beryllium	1 U		1 U	1 U	1 U
104 M	Cadmium	5 U		5 U	5 U	5 U
105 M	Chromium	5 U		5 U	5 U	5 U
106 M	Copper	4 U		4 U	13.7 B	5.5 B
107 M	Lead	2 UW		2 UW	2 U	5.5 UW
108 M	Mercury	0.2 U		0.2 U	0.2 UNW	0.2 U
109 M	Nickel	29 U		29 U	29 U	29 U
110 M	Selenium	10 UWN		10 UWN	2 UWN	2 UWN
111 M	Silver	4 U		5.8 B	4 U	4 U
112 M	Thallium	2 U		2 UW	2 U	2 U
113 M	Zinc	2920		13000	49.2	28
114 M	Barium	30 B		135 B	11.2 B	11.6 B
115 M	Iron	64 B		4810	27.9 B	5.5 B
116 M	Manganese	58.7		499	5.3 B	1 U
117 M	Vanadium	2 U		4.6 B	4 B	4.1 B
118 M	Aluminum	21.7 B		22.3 B	16 U	16 U
120 M	Cobalt	3 U		6.1 B	3 U	3 U
121 M	Magnesium	1420 BE		3270 BE	1040 BE	1060 BE
129 M	Calcium	5190		11300	2710 B	2760 B
130 M	Sodium	15100		56700	6900	6900
131 M	Potassium	1290 U		1840 B	1260 U	1390 B
201 V	Acrolein	10 U				10 U
202 V	Acrylonitrile	10 U				10 U
203 V	Benzene	5 U	2 J	5 U	5 U	5 U
205 V	Bromoform	5 U	50 U	5 U	5 U	5 U
206 V	Carbon tetrachloride	5 U	50 U	5 U	5 U	5 U
207 V	Chlorobenzene	5 U	50 U	5 U	5 U	5 U
208 V	Dibromochloromethane	5 U	50 U	5 U	5 U	5 U
209 V	Chloroethane	10 U	100 U	10 U	10 U	10 U
210 V	2-Chloroethyl vinyl ether	5 U				5 U
211 V	Chloroform	5 U	50 U	5 U	5 U	5 U
212 V	Bromodichloromethane	5 U	50 U	5 U	5 U	5 U
214 V	1,1-Dichloroethane	5 U	50 U	5 U	5 U	5 U
215 V	1,2-Dichloroethane	5 U	50 U	5 U	5 U	5 U
216 V	1,1-Dichloroethane	5 U	50 U	5 U	5 U	5 U
217 V	1,2-Dichloropropane	5 U	50 U	5 U	5 U	5 U
218 V	Cis-1,3-Dichloropropane	5 U	50 U	5 U	5 U	5 U
219 V	Ethylbenzene	5 U	50 U	5 U	5 U	5 U
220 V	Bromomethane	5 U	50 U	5 U	5 U	5 U
221 V	Chloromethane	10 U	100 U	10 U	10 U	10 U
222 V	Methylene chloride	10 U	100 U	10 U	10 U	10 U
223 V	1,1,2,2-Tetrachloroethane	5 U	50 U	5 U	5 U	5 U
224 V	Tetrachloroethane	5 U	50 U	5 U	5 U	5 U
225 V	Toluene	5 U	50 U	5 U	5 U	5 U
227 V	1,1,1-Trichloroethane	5 U	50 U	2 J	5 U	5 U
228 V	1,1,2-Trichloroethane	5 U	50 U	5 U	5 U	5 U
229 V	Trichloroethane	5 U	50 U	5 U	5 U	5 U
231 V	Vinyl chloride	5 U	1900 D	63	39	1 U
250 V	Trans-1,3-Dichloropropane	10 U	100 U	10 U	10 U	10 U
251 V	Styrene	5 U	50 U	5 U	5 U	5 U
252 V	Acetone	5 U	50 U	5 U	5 U	5 U
253 V	2-Butanone	10 U	320 D	200	10 U	10 U
254 V	Carbon disulfide	10 U	100 U	10 U	10 U	10 U
255 V	2-Hexanone	5 U	50 U	5 U	5 U	5 U
256 V	4-Methyl-2-pentanone	10 U	100 U	10 U	10 U	10 U
257 V	Vinyl acetate	10 U	100 U	10 U	10 U	10 U
258 V	Xylenes (Total)	10 U	100 U	10 U	10 U	10 U
259 V	1,2-Dichloroethane (Total)	5 U	50 U	5 U	5 U	5 U
401 B	Asenaphthene	5 U	290 D	7	5 U	5 U
402 B	Asenaphthylene	10 U		10 U	10 U	10 U
403 B	Anthracene	10 U		10 U	10 U	10 U

COLLIERVILLE SITE REMEDIAL INVESTIGATION: PHASE 1 GROUND WATER ANALYSIS SUMMARY

CMP	CL	POINT SAMPLE CMPD-DESC	MW16	MW21	MW23	WEST CITY WELL	EAST CITY WELL
			12208916 ug/L	12208921 ug/L	12198923 ug/L	122089WC ug/L	122089EC ug/L
405	B	Benzo(a)anthracene	10 U		10 U	10 U	10 U
406	B	Benzo(a)pyrene	10 U		10 U	10 U	10 U
407	B	Benzo(b)fluoranthene	10 U		10 U	10 U	10 U
408	B	Benzo(g,h,i)perylene	10 U		10 U	10 U	10 U
409	B	Benzo(k)fluoranthene	10 U		10 U	10 U	10 U
410	B	bis(2-Chloroethoxy)methane	10 U		10 U	10 U	10 U
411	B	bis(2-Chloroethyl)ether	10 U		10 U	10 U	10 U
412	B	bis(2-Chloroisopropyl)ether	10 U		10 U	10 U	10 U
413	B	bis(2-Ethylhexyl)phthalate	10 U		2 J	10 U	10 U
414	B	4-Bromophenyl phenyl ether	10 U		10 U	10 U	10 U
415	B	Butyl benzyl phthalate	10 U		10 U	10 U	10 U
416	B	2-Chloronaphthalene	10 U		10 U	10 U	10 U
417	B	4-Chlorophenyl phenyl ether	10 U		10 U	10 U	10 U
418	B	Chrysene	10 U		10 U	10 U	10 U
419	B	Dibenzo(a,h)anthracene	10 U		10 U	10 U	10 U
420	B	1,2-Dichlorobenzene	10 U		10 U	10 U	10 U
421	B	1,3-Dichlorobenzene	10 U		10 U	10 U	10 U
422	B	1,4-Dichlorobenzene	10 U		10 U	10 U	10 U
423	B	3,3'-Dichlorobenzidine	20 U		20 U	20 U	20 U
424	B	Diethyl phthalate	10 U		10 U	10 U	10 U
425	B	Dimethyl phthalate	10 U		10 U	10 U	10 U
426	B	Di-n-butyl phthalate	10 U		10 U	10 U	10 U
427	B	2,4-Dinitrotoluene	10 U		10 U	10 U	10 U
428	B	2,6-Dinitrotoluene	10 U		10 U	10 U	10 U
429	B	Di-n-octyl phthalate	10 U		10 U	10 U	10 U
431	B	Fluoranthene	10 U		10 U	10 U	10 U
432	B	Fluorene	10 U		10 U	10 U	10 U
433	B	Hexachlorobenzene	10 U		10 U	10 U	10 U
434	B	Hexachlorobutadiene	10 U		10 U	10 U	10 U
435	B	Hexachlorocyclopentadiene	10 U		10 U	10 U	10 U
436	B	Hexachloroethane	10 U		10 U	10 U	10 U
437	B	Indeno(1,2,3-cd)pyrene	10 U		10 U	10 U	10 U
438	B	Isophorone	10 U		10 U	10 U	10 U
439	B	Naphthalene	10 U		10 U	10 U	10 U
440	B	Nitrobenzene	10 U		10 U	10 U	10 U
442	B	N-Nitroso-di-n-propylamine	10 U		10 U	10 U	10 U
443	B	N-Nitrosodiphenylamine(1)	10 U		10 U	10 U	10 U
444	B	Phenanthrene	10 U		10 U	10 U	10 U
445	B	Pyrene	10 U		10 U	10 U	10 U
446	B	1,2,4-Trichlorobenzene	10 U		10 U	10 U	10 U
474	B	Benzyl alcohol	10 U		10 U	10 U	10 U
475	B	4-Chloroaniline	10 U		10 U	10 U	10 U
476	B	Dibenzofuran	10 U		10 U	10 U	10 U
477	B	2-Methylnaphthalene	10 U		10 U	10 U	10 U
478	B	2-Nitroaniline	50 U		50 U	50 U	50 U
479	B	3-Nitroaniline	50 U		50 U	50 U	50 U
480	B	4-Nitroaniline	50 U		50 U	50 U	50 U
601	A	2-Chlorophenol	10 U		10 U	10 U	10 U
602	A	2,4-Dichlorophenol	10 U		10 U	10 U	10 U
603	A	2,4-Dimethylphenol	10 U		10 U	10 U	10 U
604	A	4,6-Dinitro-2-methylphenol	50 U		50 U	50 U	50 U
605	A	2,4-Dinitrophenol	50 U		50 U	50 U	50 U
606	A	2-Nitrophenol	10 U		10 U	10 U	10 U
607	A	4-Nitrophenol	50 U		50 U	50 U	50 U
608	A	4-Chloro-3-methylphenol	10 U		10 U	10 U	10 U
609	A	Pentachlorophenol	50 U		50 U	50 U	50 U
610	A	Phenol	10 U		10 U	10 U	10 U
611	A	2,4,6-Trichlorophenol	10 U		10 U	10 U	10 U
620	A	2-Methylphenol	10 U		10 U	10 U	10 U
622	A	4-Methylphenol	10 U		10 U	10 U	10 U
625	A	Benzoic acid	50 U		50 U	50 U	50 U
626	A	2,4,5-Trichlorophenol	50 U		50 U	50 U	50 U

COLLIERVILLE SITE REMEDIAL INVESTIGATION: PHASE 1 GROUND WATER ANALYSIS SUMMARY

CMP	CL	POINT	MW16	MW21	MW23	WEST CITY WELL	EAST CITY WELL
		SAMPLE	12208916	12208921	12168923	122089WC	122089EC
		CMPD-DESC	ug/L	ug/L	ug/L	ug/L	ug/L
701	P	Aldrin	0.05 U		0.05 U	0.05 U	0.05 U
702	P	Alpha-BHC	0.05 U		0.05 U	0.05 U	0.05 U
703	P	Beta-BHC	0.05 U		0.05 U	0.05 U	0.05 U
704	P	Gamma-BHC (Lindane)	0.05 U		0.05 U	0.05 U	0.05 U
706	P	Delta-BHC	0.05 U		0.05 U	0.05 U	0.05 U
707	P	4,4'-DDT	0.1 U		0.1 U	0.1 U	0.1 U
708	P	4,4'-DDE	0.1 U		0.1 U	0.1 U	0.1 U
709	P	4,4'-DDD	0.1 U		0.1 U	0.1 U	0.1 U
710	P	Dieldrin	0.1 U		0.1 U	0.1 U	0.1 U
711	P	Endosulfan I	0.05 U		0.05 U	0.05 U	0.05 U
712	P	Endosulfan II	0.1 U		0.1 U	0.1 U	0.1 U
713	P	Endosulfan sulfate	0.1 U		0.1 U	0.1 U	0.1 U
714	P	Endrin	0.1 U		0.1 U	0.1 U	0.1 U
716	P	Heptachlor	0.05 U		0.05 U	0.05 U	0.05 U
717	P	Heptachlor epoxide	0.05 U		0.05 U	0.05 U	0.05 U
718	P	PCB-1242	0.5 U		0.5 U	0.5 U	0.5 U
719	P	PCB-1254	1 U		1 U	1 U	1 U
720	P	PCB-1221	0.5 U		0.5 U	0.5 U	0.5 U
721	P	PCB-1232	0.5 U		0.5 U	0.5 U	0.5 U
722	P	PCB-1248	0.5 U		0.5 U	0.5 U	0.5 U
723	P	PCB-1260	1 U		1 U	1 U	1 U
724	P	PCB-1016	0.5 U		0.5 U	0.5 U	0.5 U
725	P	Toxaphene	1 U		1 U	1 U	1 U
726	P	p,p'-Methoxychlor	0.5 U		0.5 U	0.5 U	0.5 U
739	P	Endrin ketone	0.1 U		0.1 U	0.1 U	0.1 U
747	P	Alpha chlordane	0.5 U		0.5 U	0.5 U	0.5 U
748	P	Gamma chlordane	0.5 U		0.5 U	0.5 U	0.5 U
1001	C	Cyanide	10 U AS		10 U AS	10 U AS	10 U AS

APPENDIX D

HISTORICAL MONITORING WELL DATA TABLES

MONITORING WELL HISTORICAL DATA

WELL	DATE	TCE(ppb)	DCE(ppb)
MW01	07/10/86	3.8	<1
MW01	07/10/86	3.8	<1
MW01	09/15/86	260	<1
MW01	10/20/86	53	1.4
MW01	10/28/86	64	3
MW01	11/03/86	210	2
MW01	11/12/86	65	3.6
MW01	11/20/86	38	1.7
MW01	12/04/86	46	2.6
MW01	12/11/86	110	6.4
MW01	12/17/86	115	6
MW01	12/23/86	107	5.2
MW01	12/30/86	81.5	8.2
MW01	01/07/87	105	7.5
MW01	01/22/87	105.5	7.5
MW01	01/29/87	120	8.2
MW01	02/12/87	110	7.9
MW01	02/18/87	125	8.2
MW01	02/26/87	120	6.8
MW01	03/05/87	120	8
MW01	03/12/87	155	7.9
MW01	03/20/87	125	8.7
MW01	03/25/87	190	8.9
MW01	04/03/87	155	8.9
MW01	04/09/87	130	10
MW01	04/16/87	140	9.7
MW01	04/23/87	180	8.8
MW01	04/30/87	180	8.8
MW01	05/06/87	150	8.8
MW01	05/14/87	130	8.8
MW01	05/21/87	205	11
MW01	05/28/87	230	11
MW01	06/04/87	130	10.5
MW01	06/18/87	220	11
MW01	06/25/87	150	10.5
MW01	07/02/87	200	11.5
MW01	07/09/87	180	11
MW01	07/16/87	235	12.5
MW01	07/23/87	225	10.4
MW01	08/20/87	195	12.5
MW01	08/27/87	235	12
MW01	09/03/87	200	11.5
MW01	09/17/87	190	13
MW01	09/28/87	165	12
MW01	10/15/87	215	8

MONITORING WELL HISTORICAL DATA

WELL	DATE	TCE(ppb)	DCE(ppb)
MW01	07/10/86	3.8	<1
MW01	11/17/87	305	11.5
MW01	12/09/87	250	15.5
MW01	01/21/88	275	16
MW01	02/17/88	360	22
MW01	03/16/88	290	24
MW01	04/27/88	280	23.5
MW01	05/26/88	270	26.5
MW01	06/27/88	580	34
MW01	07/26/88	415	21.5
MW01	08/29/88	295	24.5
MW01	09/28/88	165	24.5
MW01	10/24/88	85.5	6.5
MW01	12/28/88	365	26
MW01	02/16/89	630	39.5
MW01	04/25/89	255	36
MW01	05/30/89	440	38
MW01	06/26/89	465	40.5
MW01	07/27/89	495	53.5
MW01	08/31/89	540	55.5
MW01	09/28/89	485	39.5
MW01A	12/09/87	19	10
MW01A	01/21/88	NS	NS
MW01A	02/17/88	11	8
MW01A	03/16/88	22	12
MW01A	04/27/88	NS	NS
MW01A	05/26/88	NS	NS
MW01A	06/27/88	NS	NS
MW01A	07/26/88	NS	NS
MW01A	08/29/88	NS	NS
MW01A	09/28/88	NS	NS
MW01A	10/24/88	NS	NS
MW01A	12/28/88	NS	NS
MW01A	02/16/89	3	1
MW01A	04/25/89	NS	NS
MW01A	05/30/89	NS	NS
MW01A	06/26/89	NS	NS
MW01A	07/27/89	NS	NS
MW01A	08/31/89	NS	NS
MW01A	09/28/89	NS	NS
MW01B	08/20/87	220	15
MW01B	08/27/87	390	23
MW01B	09/03/87	380	24
MW01B	09/17/87	305	17.5
MW01B	09/28/87	300	24

MONITORING WELL HISTORICAL DATA

WELL	DATE	TCE(ppb)	DCE(ppb)
MW01	07/10/86	3.8	<1
MW01B	10/15/87	330	27
MW01B	11/17/87	620	28
MW01B	12/09/87	490	32
MW01B	01/21/88	790	44
MW01B	02/17/88	820	47
MW01B	03/16/88	340	44
MW01B	04/27/88	500	52
MW01B	05/26/88	420	47
MW01B	06/27/88	760	67
MW01B	07/26/88	440	72
MW01B	08/29/88	440	120
MW01B	09/28/88	77	31
MW01B	10/24/88	130	41
MW01B	12/28/88	310	180
MW01B	02/16/89	320	140
MW01B	04/25/89	490	200
MW01B	05/30/89	940	330
MW01B	06/26/89	1100	140
MW01B	07/27/89	580	290
MW01B	08/31/89	760	250
MW01B	09/28/89	850	240
MW03	10/15/87	2400	2802.1
MW03	11/17/87	3400	2300
MW03	12/09/87	2500	2700
MW03	01/21/88	1800	1300
MW03	02/17/88	4100	4200
MW03	03/16/88	1600	2000
MW03	04/27/88	2800	6600
MW03	05/26/88	5200	5300
MW03	06/27/88	3300	6800
MW03	07/26/88	3100	5100
MW03	08/29/88	2500	5100
MW03	09/28/88	8000	61
MW03	10/24/88	2600	5500
MW03	12/28/88	1300	490
MW03	02/16/89	5400	8100
MW03	04/25/89	2900	2800
MW03	05/30/89	5000	3800
MW03	06/26/89	6000	4600
MW03	07/27/89	6200	5000
MW03	08/31/89	7800	4800
MW03	09/28/89	5000	3700
MW04	10/15/87	46	2.3
MW04	11/17/87	16	0.7

MONITORING WELL HISTORICAL DATA

WELL	DATE	TCE(ppb)	DCE(ppb)
MW01	07/10/86	3.8	<1
MW04	12/09/87	150	9
MW04	01/21/88	210	13
MW04	02/17/88	14	1
MW04	03/16/88	12	<1
MW04	04/27/88	46	4
MW04	05/26/88	38	4
MW04	06/27/88	13	<1
MW04	07/26/88	82	4
MW04	08/29/88	200	15
MW04	09/28/88	140	20
MW04	10/24/88	120	14
MW04	12/28/88	160	16
MW04	02/16/89	360	22
MW04	04/25/89	130	18
MW04	05/30/89	41	4
MW04	06/26/89	42	4
MW04	07/27/89	9	1
MW04	08/31/89	13	2
MW04	09/28/89	19	
MW05	10/15/87	260	6700
MW05	11/17/87	1200	7025
MW05	12/09/87	1900	9016
MW05	01/21/88	4800	4113
MW05	02/17/88	3200	6914
MW05	03/16/88	3100	6200
MW05	04/27/88	2200	2211
MW05	05/26/88	9000	1700
MW05	06/27/88	4500	229
MW05	07/26/88	6500	3300
MW05	08/29/88	8200	5500
MW05	09/28/88	4200	4200
MW05	10/24/88	4700	5400
MW05	12/28/88	1500	4000
MW05	02/16/89	760	8000
MW05	04/25/89	7500	3400
MW05	05/30/89	4600	5000
MW05	06/26/89	5600	3600
MW05	07/27/89	11000	1100
MW05	08/31/89	4400	1700
MW05	09/28/89	7300	1800
MW06	10/15/87	<1	<1
MW06	11/17/87	NS	NS
MW06	12/09/87	<1	<1
MW06	01/21/88	<1	<1

MONITORING WELL HISTORICAL DATA

WELL	DATE	TCE(ppb)	DCE(ppb)
MW01	07/10/86	3.8	<1
MW06	02/17/88	<1	<1
MW06	03/16/88	<1	<1
MW06	04/27/88	<1	<1
MW06	05/26/88	<1	<1
MW06	06/27/88	NS	NS
MW06	07/26/88	NS	NS
MW06	08/29/88	NS	NS
MW06	09/28/88	1	<1
MW06	10/24/88	<1	<1
MW06	12/28/88	<1	<1
MW06	02/16/89	<1	<1
MW06	04/25/89	NS	NS
MW06	05/30/89	5	<1
MW06	06/26/89	1	<1
MW06	07/27/89	1	<1
MW06	08/31/89	1	<1
MW06	09/28/89	2	<1
MW09	03/16/88	20	<1
MW09	04/27/88	NS	NS
MW09	05/26/88	NS	NS
MW09	06/27/88	NS	NS
MW09	07/26/88	NS	NS
MW09	08/29/88	30	<1
MW09	09/28/88	NS	NS
MW09	10/24/88	NS	NS
MW09	12/28/88	NS	NS
MW09	02/16/89	NS	NS
MW09	04/25/89	NS	NS
MW09	05/30/89	NS	NS
MW09	06/26/89	NS	NS
MW09	07/27/89	NS	NS
MW09	08/31/89	NS	NS
MW09	09/28/89	NS	NS
MW10	07/10/86	NS	NS
MW10	09/15/86	2.4	<1
MW10	10/20/86	1	<1
MW10	10/28/86	2.8	<1
MW10	11/03/86	<1	<1
MW10	11/12/86	<1	<1
MW10	11/20/86	<1	<1
MW10	12/04/86	<1	<1
MW10	12/11/86	NS	NS
MW10	12/17/86	NS	NS
MW10	12/23/86	NS	NS

MONITORING WELL HISTORICAL DATA

WELL	DATE	TCE(ppb)	DCE(ppb)
MW01	07/10/86	3.8	<1
MW10	12/30/86	NS	NS
MW10	01/07/87	NS	NS
MW10	01/22/87	NS	NS
MW10	01/29/87	NS	NS
MW10	02/12/87	NS	NS
MW10	02/18/87	NS	NS
MW10	02/26/87	NS	NS
MW10	03/05/87	NS	NS
MW10	03/12/87	NS	NS
MW10	03/20/87	NS	NS
MW10	03/25/87	<1	<1
MW10	04/03/87	NS	NS
MW10	04/09/87	NS	NS
MW10	04/16/87	NS	NS
MW10	04/23/87	NS	NS
MW10	04/30/87	NS	NS
MW10	05/06/87	NS	NS
MW10	05/14/87	NS	NS
MW10	05/21/87	NS	NS
MW10	05/28/87	NS	NS
MW10	06/04/87	NS	NS
MW10	06/18/87	NS	NS
MW10	06/25/87	NS	NS
MW10	07/02/87	NS	NS
MW10	07/09/87	NS	NS
MW10	07/16/87	NS	NS
MW10	07/23/87	NS	NS
MW10	08/20/87	<1	<1
MW10	08/27/87	NS	NS
MW10	09/03/87	NS	NS
MW10	09/17/87	NS	NS
MW10	09/28/87	NS	NS
MW10	10/15/87	<1	<1
MW10	11/17/87	NS	NS
MW10	12/09/87	NS	NS
MW10	01/21/88	NS	NS
MW10	02/17/88	NS	NS
MW10	03/16/88	NS	NS
MW10	04/27/88	<1	<1
MW10	05/26/88	NS	NS
MW10	06/27/88	NS	NS
MW10	07/26/88	NS	NS
MW10	08/29/88	NS	NS
MW10	09/28/88	NS	NS

MONITORING WELL HISTORICAL DATA

WELL	DATE	TCE(ppb)	DCE(ppb)
MW01	07/10/86	3.8	<1
MW10	10/24/88	NS	NS
MW10	12/28/88	<1	<1
MW10	02/16/89	NS	NS
MW10	04/25/89	NS	NS
MW10	05/30/89	NS	NS
MW10	06/26/89	<1	<1
MW10	07/27/89	NS	NS
MW10	08/31/89	NS	NS
MW10	09/28/89	NS	NS
MW11	02/17/88	23	<1
MW11	03/16/88	NS	NS
MW11	04/27/88	NS	NS
MW11	05/26/88	NS	NS
MW11	06/27/88	NS	NS
MW11	07/26/88	NS	NS
MW11	08/29/88	NS	NS
MW11	09/28/88	NS	NS
MW11	10/24/88	NS	NS
MW11	12/28/88	NS	NS
MW11	02/16/89	NS	NS
MW11	04/25/89	NS	NS
MW11	05/30/89	NS	NS
MW11	06/26/89	NS	NS
MW11	07/27/89	NS	NS
MW11	08/31/89	NS	NS
MW11	09/28/89	NS	NS
MW12	07/10/86	1.9	<1
MW12	09/15/86	<1	<1
MW12	10/20/86	<1	<1
MW12	10/28/86	<1	<1
MW12	11/03/86	<1	<1
MW12	11/12/86	<1	<1
MW12	11/20/86	<1	<1
MW12	12/04/86	<1	<1
MW12	12/11/86	NS	NS
MW12	12/17/86	NS	NS
MW12	12/23/86	NS	NS
MW12	12/30/86	NS	NS
MW12	01/07/87	NS	NS
MW12	01/22/87	NS	NS
MW12	01/29/87	NS	NS
MW12	02/12/87	NS	NS
MW12	02/18/87	NS	NS
MW12	02/26/87	NS	NS

MONITORING WELL HISTORICAL DATA

WELL	DATE	TCE(ppb)	DCE(ppb)
MW01	07/10/86	3.8	<1
MW12	03/05/87	NS	NS
MW12	03/12/87	NS	NS
MW12	03/20/87	NS	NS
MW12	03/25/87	<1	<1
MW12	04/03/87	NS	NS
MW12	04/09/87	NS	NS
MW12	04/16/87	NS	NS
MW12	04/23/87	NS	NS
MW12	04/30/87	NS	NS
MW12	05/06/87	NS	NS
MW12	05/14/87	NS	NS
MW12	05/21/87	NS	NS
MW12	05/28/87	NS	NS
MW12	06/04/87	NS	NS
MW12	06/18/87	NS	NS
MW12	06/25/87	NS	NS
MW12	07/02/87	NS	NS
MW12	07/09/87	NS	NS
MW12	07/16/87	NS	NS
MW12	07/23/87	NS	NS
MW12	08/20/87	<1	<1
MW12	08/27/87	NS	NS
MW12	09/03/87	NS	NS
MW12	09/17/87	NS	NS
MW12	09/28/87	NS	NS
MW12	10/15/87	<1	<1
MW12	11/17/87	NS	NS
MW12	12/09/87	NS	NS
MW12	01/21/88	NS	NS
MW12	02/17/88	NS	NS
MW12	03/16/88	NS	NS
MW12	04/27/88	<1	<1
MW12	05/26/88	NS	NS
MW12	06/27/88	NS	NS
MW12	07/26/88	NS	NS
MW12	08/29/88	NS	NS
MW12	09/28/88	NS	NS
MW12	10/24/88	NS	NS
MW12	12/28/88	NS	NS
MW12	02/16/89	NS	NS
MW12	04/25/89	NS	NS
MW12	05/30/89	NS	NS
MW12	06/26/89	<1	<1
MW12	07/27/89	NS	NS

MONITORING WELL HISTORICAL DATA

WELL	DATE	TCE(ppb)	DCE(ppb)
MW01	07/10/86	3.8	<1
MW12	08/31/89	NS	NS
MW12	09/28/89	NS	NS
MW13	07/10/86	<1	<1
MW13	09/15/86	105	<1
MW13	10/20/86	120	<1
MW13	10/28/86	100	<1
MW13	11/03/86	110	<1
MW13	11/12/86	100	<1
MW13	11/20/86	110	<1
MW13	12/04/86	97	<1
MW13	12/11/86	92	<1
MW13	12/17/86	110	<1
MW13	12/23/86	120	<1
MW13	12/30/86	77	<1
MW13	01/07/87	98	<1
MW13	01/22/87	110	<1
MW13	01/29/87	120	<1
MW13	02/12/87	120	<1
MW13	02/18/87	130	<1
MW13	02/26/87	130	<1
MW13	03/05/87	140	<1
MW13	03/12/87	160	<1
MW13	03/20/87	140	<1
MW13	03/25/87	230	<1
MW13	04/03/87	160	<1
MW13	04/09/87	160	<1
MW13	04/16/87	160	<1
MW13	04/23/87	190	<1
MW13	04/30/87	195	<1
MW13	05/06/87	145	<1
MW13	05/14/87	140	<1
MW13	05/21/87	210	<1
MW13	05/28/87	190	<1
MW13	06/04/87	140	<1
MW13	06/18/87	210	<1
MW13	06/25/87	140	<1
MW13	07/02/87	180	<1
MW13	07/09/87	160	<1
MW13	07/16/87	59	<1
MW13	07/23/87	180	<1
MW13	08/20/87	160	<1
MW13	08/27/87	NS	NS
MW13	09/03/87	NS	NS
MW13	09/17/87	NS	NS

MONITORING WELL HISTORICAL DATA

WELL	DATE	TCE(ppb)	DCE(ppb)
MW01	07/10/86	3.8	<1
MW13	09/28/87	NS	NS
MW13	10/15/87	100	<1
MW13	11/17/87	200	<1
MW13	12/09/87	190	<1
MW13	01/21/88	210	<1
MW13	02/17/88	190	<1
MW13	03/16/88	120	<1
MW13	04/27/88	140	<1
MW13	05/26/88	160	<1
MW13	06/27/88	180	<1
MW13	07/26/88	140	<1
MW13	08/29/88	120	<1
MW13	09/28/88	100	<1
MW13	10/24/88	100	<1
MW13	12/28/88	130	<1
MW13	02/16/89	230	<1
MW13	04/25/89	180	<1
MW13	05/30/89	150	<1
MW13	06/26/89	200	1
MW13	07/27/89	97	1
MW13	08/31/89	120	<1
MW13	09/28/89	120	<1
MW14	07/10/86	NS	NS
MW14	09/15/86	<1	<1
MW14	10/20/86	<1	<1
MW14	10/28/86	<1	<1
MW14	11/03/86	<1	<1
MW14	11/12/86	<1	<1
MW14	11/20/86	<1	<1
MW14	12/04/86	<1	<1
MW14	12/11/86	NS	NS
MW14	12/17/86	NS	NS
MW14	12/23/86	NS	NS
MW14	12/30/86	NS	NS
MW14	01/07/87	NS	NS
MW14	01/22/87	NS	NS
MW14	01/29/87	NS	NS
MW14	02/12/87	NS	NS
MW14	02/18/87	NS	NS
MW14	02/26/87	NS	NS
MW14	03/05/87	NS	NS
MW14	03/12/87	NS	NS
MW14	03/20/87	NS	NS
MW14	03/25/87	<1	<1

MONITORING WELL HISTORICAL DATA

WELL	DATE	TCE(ppb)	DCE(ppb)
MW01	07/10/86	3.8	<1
MW14	04/03/87	NS	NS
MW14	04/09/87	NS	NS
MW14	04/16/87	NS	NS
MW14	04/23/87	NS	NS
MW14	04/30/87	NS	NS
MW14	05/06/87	NS	NS
MW14	05/14/87	NS	NS
MW14	05/21/87	NS	NS
MW14	05/28/87	NS	NS
MW14	06/04/87	NS	NS
MW14	06/18/87	NS	NS
MW14	06/25/87	NS	NS
MW14	07/02/87	NS	NS
MW14	07/09/87	NS	NS
MW14	07/16/87	NS	NS
MW14	07/23/87	NS	NS
MW14	08/20/87	<1	<1
MW14	08/27/87	NS	NS
MW14	09/03/87	NS	NS
MW14	09/17/87	NS	NS
MW14	09/28/87	NS	NS
MW14	10/15/87	<1	<1
MW14	11/17/87	NS	NS
MW14	12/09/87	NS	NS
MW14	01/21/88	NS	NS
MW14	02/17/88	NS	NS
MW14	03/16/88	NS	NS
MW14	04/27/88	<1	<1
MW14	05/26/88	NS	NS
MW14	06/27/88	NS	NS
MW14	07/26/88	NS	NS
MW14	08/29/88	NS	NS
MW14	09/28/88	NS	NS
MW14	10/24/88	NS	NS
MW14	12/28/88	<1	<1
MW14	02/16/89	NS	NS
MW14	04/25/89	NS	NS
MW14	05/30/89	NS	NS
MW14	06/26/89	<1	<1
MW14	07/27/89	NS	NS
MW14	08/31/89	NS	NS
MW14	09/28/89	NS	NS
MW15	12/09/87	38000	66
MW15	01/21/88	150000	180

MONITORING WELL HISTORICAL DATA

WELL	DATE	TCE(ppb)	DCE(ppb)
MW01	07/10/86	3.8	<1
MW15	02/17/88	120000	180
MW15	03/16/88	59000	<1
MW15	04/27/88	940	140
MW15	05/26/88	NS	NS
MW15	06/27/88	NS	NS
MW15	07/26/88	19000	<1
MW15	08/29/88	55000	65
MW15	09/28/88	20000	170
MW15	10/24/88	120000	<1
MW15	12/28/88	5900	37
MW15	02/16/89	64000	<1
MW15	04/25/89	140000	190
MW15	05/30/89	NS	NS
MW15	06/26/89	4000000	<1
MW15	07/27/89	NS	NS
MW15	08/31/89	NS	NS
MW15	09/28/89	NS	NS
MW16	06/27/88	<1	<1
MW16	07/26/88	<1	<1
MW16	08/29/88	<1	<1
MW16	09/28/88	<1	<1
MW16	10/24/88	<1	<1
MW16	12/28/88	<1	<1
MW16	02/16/89	<1	<1
MW16	04/25/89	NS	NS
MW16	05/30/89	NS	NS
MW16	06/26/89	<1	<1
MW16	07/27/89	NS	NS
MW16	08/31/89	NS	NS
MW16	09/28/89	NS	NS
MW19	12/09/87	37000	55
MW19	01/21/88	19000	<1
MW19	02/17/88	17000	300
MW19	03/16/88	2300	730
MW19	04/27/88	19000	660
MW19	05/26/88	13000	2500
MW19	06/27/88	17000	1000
MW19	07/26/88	14000	3700
MW19	08/29/88	7000	7800
MW19	09/28/88	5300	6500
MW19	10/24/88	10000	12000
MW19	12/28/88	1000	3800
MW19	02/16/89	1800	13000
MW19	04/25/89	47	240

MONITORING WELL HISTORICAL DATA

WELL	DATE	TCE(ppb)	DCE(ppb)
MW01	07/10/86	3.8	<1
MW19	05/30/89	840	26000
MW19	06/26/89	560	17000
MW19	07/27/89	640	12000
MW19	08/31/89	18000	14000
MW19	09/28/89	2800	23034
MW21	12/09/87	36000	<1
MW21	01/21/88	20000	<1
MW21	02/17/88	16000	<1
MW21	03/16/88	360	24
MW21	04/27/88	4800	1600
MW21	05/26/88	4700	240
MW21	06/27/88	6800	680
MW21	07/26/88	5400	2300
MW21	08/29/88	10000	660
MW21	09/28/88	4700	2400
MW21	10/24/88	9500	450
MW21	12/28/88	1900	500
MW21	02/16/89	3100	240
MW21	04/25/89	7	<1
MW21	05/30/89	2500	920
MW21	06/26/89	9400	340
MW21	07/27/89	3300	1400
MW21	08/31/89	3000	1300
MW21	09/28/89	2500	360
MW23	12/09/87	72	<1
MW23	01/21/88	44	<1
MW23	02/17/88	30	<1
MW23	03/16/88	44	<1
MW23	04/27/88	3	<1
MW23	05/26/88	57	<1
MW23	06/27/88	40	2
MW23	07/26/88	79	<1
MW23	08/29/88	56	5
MW23	09/28/88	14	2
MW23	10/24/88	46	7
MW23	12/28/88	33	5
MW23	02/16/89	36	5
MW23	04/25/89	91	2
MW23	05/30/89	82	2
MW23	06/26/89	95	2
MW23	07/27/89	58	3
MW23	08/31/89	66	2
MW23	09/28/89	83	5

NS = Not sampled